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AGRONOMY, HANDLING, PROCESSING, STORAGE AND PROTECTION
SOILS, CHEMICALS, IRRIGATION, ENGINEERING AND ECONOMICS

Rotavation of Sugar Cane in Cuba

VOLUME 5, No. 4 APRIL 1953

A Publication of The Leonard Hill Technical Group

Sugar cane growers using Monsanto's chemicals for weed control gained savings in weeding costs ranging from 20 to 30 per cent. Monsanto is actively carrying on field research work in the Caribbean area, notably in the British West Indies and Cuba.

The advantages of

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Methods of treatment

The chemicals supplied by Monsanto for the treatment of weeds in sugar cane are:—

Chemical	*Technical description*	*Purpose*
2.4-D	2.4 - Dichlorophenoxy-acetic acid. Sodium Salt of 2.4 - Dichlorophenoxy-acetic acid. Dimethylamine Salt of 2.4-Dichlorophenoxyacetic acid.	Hormone - type herbicide for pre-emergence and post - emergence application.
Santophen -20	Pentachlorophenol.	Contact weed-killer (in oil) and as mixed hormone - type contact weed-killer.
Santobrite	Sodium pentachlorophenate.	Water - soluble contact herbicide.

The Special Products Department of Monsanto Chemicals Limited will be pleased to supply growers, manufacturers and formulators with further information.

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WORLD CROPS

Editor: Sir Harold A. Tempany, C.M.G., C.B.E., D.SC., F.R.I.C.

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Rotavation of Sugar Cane in Cuba

The front cover picture shows a narrow-width Rotavator working with a Ferguson vineyard type tractor on a Cuban sugar estate. Rotavation can usefully be employed for aerating the soil, maintaining correct soil structure and controlling weed growth. In addition, cane trash can be chopped up and turned in with the Rotavator.

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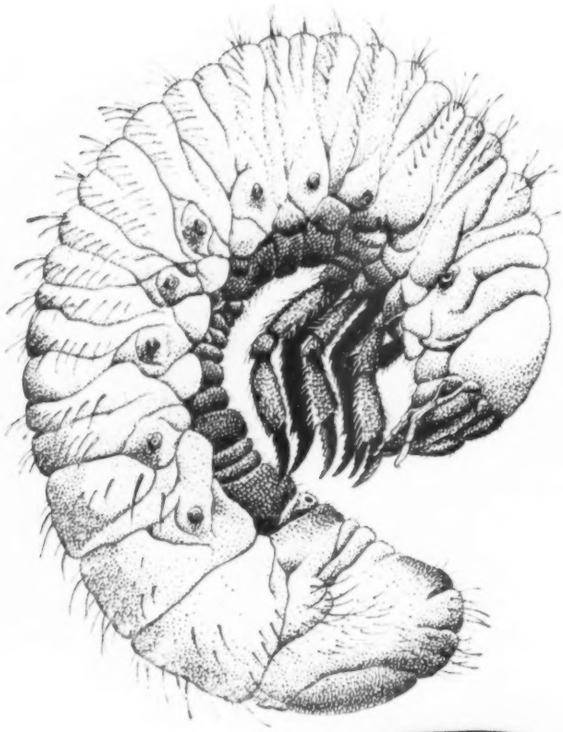

NEW fighting weapons for agriculture

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Editorial Comment

The floods in Britain . . .

THE recent flooding on the East Coast of Britain was one of those cataclysms which afflict countries once in the course of a long period of years. Indeed, it seems that it was the worst within recorded times and exceeded in violence and intensity the disastrous floods of 1703. Actually on the night of January 31 last, storms of exceptional violence and intensity in the North Sea and around Scotland combined with spring tides which reached levels exceeding any previously recorded, to produce the disaster which for destructiveness eclipses any previous similar occurrence.

The matter was debated in the House of Commons on February 20, when the Home Secretary, Sir David Maxwell Fyfe, summarised in a statement the latest information available regarding the disaster and the damage done.

It appears that a total of upwards of 1,200 separate breaches were made in coastal defences between Yorkshire and Kent, as a result of which 307 people are known have lost their lives, over 150,000 acres of land were flooded, some 32,000 people were rendered temporarily homeless and had to be evacuated, considerable damage was done to sewerage systems and water supplies, and considerable stocks of foodstuffs and other supplies were damaged, most of them irreparably.

About 25,000 houses were flooded and from 350 to 450 were destroyed, while some 200 in addition were probably damaged beyond repair.

Of the flooded land, 64,000 acres were arable land and 75,000 were grassland, but fortunately this was not so bad as might appear at first sight, since about two-thirds of the total area inundated was under water for only a short time and only about one-third was seriously damaged by sea water. Moreover, thanks to the excellent salvage work of the local farming communities, the losses of livestock were much less than was at first feared to be the case, although over 1,000 cattle, 8,000 sheep, 1,500 pigs and 20,000 head of poultry were lost.

It is reported that the problem of restoring the salt-damaged land is being examined as a matter of urgency by the Ministry of Agriculture. A conference of soil experts has been called and their advice is being made available as rapidly as possible. Adequate supplies of gypsum for application to salted lands are available and will, it is stated, be made available to farmers on favourable terms. In the meantime farmers have been advised to do nothing by way of cultivation of salted lands, pending further instructions, for fear further damage might result. It is recognised that to bring the land back into good heart is a considerable task which will take time, but the Government have agreed that this must be a national responsibility.

Meantime, it is good news that the hastily undertaken repairs to sea defences have stood firm during the seasonal spring tides which occurred during the later part of February. Fortunately weather was favourable and no further disaster supervened as was at one time feared might happen.

. . . and in the Low Countries

BUT the devastation caused on this terrible night was by no means confined to the United Kingdom, and the low-lying lands on the coasts of Holland and Belgium unfortunately were subjected to damage on a scale beside which that in Britain was almost small.

In Holland, especially, was the damage particularly severe and the loss of life heavy. Full details are not yet available in this country, but it is known, for example, that the islands of Walcheren and Beveland off the Dutch coast have been almost completely submerged, while the loss of life runs to several thousands.

It is particularly sad for Holland where recovery from the serious flood damage which occurred during the last war had only recently been achieved. Readers will recall that during the war the sea defences of Walcheren were breached by the British as part of offensive operations against the Germans who then occupied the country, and that an illustrated account of the measures undertaken by the Dutch authorities to repair the damage appeared in the first number of WORLD CROPS in 1949.

It is the earnest hope of all, including this journal, that once again the indomitable courage and skill of the Dutch authorities and agriculturalists may in due time successfully surmount this latest blow they have sustained in their unending struggle to protect the lands which they have wrested from the sea.

Salt and sense

AT a time when we are fast rediscovering—and to good value—some of salt's ancient virtues as a fertiliser, it is unfortunate that the tragic February floods in Holland and Eastern England have focused attention upon salt as a soil-damaging substance. To say this is unfortunate is not to say it is wrong—the problem of restoring productivity to the flooded farmland dwarfs most other agricultural tasks in both countries and maximum public interest should be aroused. Nevertheless, numbers of people may draw the very false conclusion that salt is always dangerous. The truth is that salt in the right amount is beneficial for a number of crops, notably sugar beet, fodder beet, mangolds and cotton, but like many other useful soil amendments it is injurious in excess. When sea-water floods soils, there is a considerable retention of salt or sodium chloride, and the longer the water remains over the land the greater the amount absorbed. With very light soils this is not so dangerous for the salt is washed out by subsequent rains in a season or two; with clay or partial-clay soils, however, the sodium displaces other elements in the clay complexes and forms what is known as a 'sodium

clay,' which is almost unworkable, sticky in wet weather and steel-hard in dry weather. This condition may not disappear by natural recovery for a number of years; but recovery can be much hastened by treatment with calcium sulphate (gypsum), substantial dressings of which will reconvert the sodium clays to the more amenable calcium clays.

No one need fear, however, that salt dressings in, say, sugar-beet manuring can produce similar effects. A typical salt dressing would be 5 cwt. per acre and this does not represent even 5 cwt. per annum since sugar beet is grown in rotation. By comparison, when sea-water lies *only* one foot deep over an acre of soil, the total weight of salt involved is at least 35 tons! If about 20% of this amount of salt is retained by the soil before the flood water disperses, it is equivalent to an application of six or seven tons of salt per acre. Any attempt, therefore, to compare flood damage by salt water with the use of salt as a fertiliser is like comparing a mountain and a mole-hill.

Mr. Churchill on British Agriculture

THE occasions on which a British Prime Minister has attended a gathering of the British National Farmers' Union and made it the occasion for a pronouncement on Government policy in relation to agriculture in the mother country must be very limited in number. If for no other reason the speech delivered by Mr. Churchill at the annual dinner of the N.F.U. on February 17 last must be reckoned as of more than ordinary importance, inasmuch as it was tantamount to a statement carrying all the weight with which an official utterance can be invested of the policy and intentions of the British Government in so far as they affect British farming. As such it afforded as plain an indication as could be wanted that the head of the administration was as profoundly convinced as any of his followers that in a sound and progressive agricultural policy the future of Great Britain is inextricably involved.

Not that the speech itself contained anything startlingly novel or enunciated principles which had not previously been clearly expounded by the Minister of Agriculture, Sir Thomas Dugdale, but coming from such a source it must of necessity carry enormous authority and weight, while like all Mr. Churchill's utterances it was embellished and emphasised by the use of that picturesque and telling phraseology of which he is an acknowledged and unrivalled master.

Thus he emphasised that 'it was not a case of choosing between food production for domestic consumption and exports; we must have both at the highest level driven forward with the fiercest energy'; He insisted that 'by 1956 home-grown food of Britain must be raised to 60% above what it was in 1939. We have already raised our food supply by 40% and the job must be finished.

'It is just as important for our future now to wring the last ounce of food from our acres year by year as it was in the dark days of the war.' His appeal here had something of the fervour and urgency which characterised his war-time utterances.

He went on to assure his hearers that it was the policy of Her Majesty's Government to make British farming stable, but this did not mean that it should be rigid; it should be strong and free for greater production and their task was, in consultation with leaders of British farming, to do this by steering a middle course between the restrictions and restraints of the 'forties and the hazards and loose freedoms of the 'thirties.

He reiterated that the Government stood by the provisions of Part I of the 1947 Agriculture Act, but went on to say that previously the policy of guaranteed prices and assured markets had been applied under a stiffly controlled system of complex regulations; the Government were convinced that departmental intervention on this scale is bound to repress the urge for expansion and freeze the current of imaginative enterprise.

He mentioned that the Government were at present endeavouring to work out with farmers' representatives, the corn trade and others the best ways and means of achieving their aims, although he gave, not altogether surprisingly, no indication of the steps envisaged.

Most people will readily concede that his speech was a magnificent oratorical effort and join in the hope that it will stimulate in the manner desired food production in Great Britain.

'Krilium' again

AFTER a year of field trials and manufacturing research, Monsanto Chemicals Ltd. have decided to market their soil conditioner *Krilium* in a special formulation for home gardeners and small growers. They have formed a new company, Monsanto (Soil Conditioners) Ltd., which will distribute the product in 1 lb. containers through the normal retail channels at 10s. 6d. per lb.

The new form of the product is called *Merloam*, and it is a calcium salt of vinyl acetate/maleic acid copolymer and not the polyacrylic acid product originally announced. This formulation is considered best for British soils at present. Instructions accompanying the product state that 1 lb. will condition 16 sq. ft. of soil to a depth of 3 in. Alternatively, by treating the soil in which each plant is to be placed with one level teaspoonful of the product, 1 lb. will suffice for about 230 plants. It is emphasised that the product is not a fertiliser but a conditioner that will turn difficult soils of most types into loose, easily workable loam. The benefits claimed are faster germination with more seeds coming through, faster growth and bigger root cultivation. Used in poorly aerated soils, it is claimed to permit plants and crops to make better use of nutrients.

At the same time as Monsanto announced their new product, the Agricultural Research Council gave a brief summary of the results obtained during 1952 with the original *Krilium* at several agricultural research institutes throughout the country. The results were not expected to be more than preliminary, because there are still many questions to be answered. For example, it is particularly necessary to know how long the effect of soil conditioners persists in the soil. No definite conclusions, therefore, can be drawn at this stage of investigation.

However, the initial findings can be summarised as follows:

(1) Improvement in structure after treatment was apparent in many of the soils tested.

(2) The uptake by plants of major and minor nutrients was not adversely affected.

(3) The activity of soil micro-organisms was normal.

(4) No conclusive evidence was obtained that the application of *Krilium* caused any significant increases in crop yields of field or of glasshouse crops, though in certain cases increased yields were recorded. Much more experimental evidence on the best method of incorporation, degree of aggregation and persistence of structure of treated soils, and the relation of these to crop yields is required before any definite conclusion can be reached.

Experiments are being continued this year and the results, when complete, will be published in the usual reports and journals.

Sorghum in Queensland

THE first number of WORLD CROPS, published in August 1949, contained a short article describing the then newly launched scheme for sorghum production in Queensland, using mechanised methods of cultivation and harvesting, as part of a project for increasing the meat supplies of the United Kingdom. The scheme originated as the result of a visit to Queensland in 1948, made by Mr. (later Sir) Leslie Plummer, former chairman of the Overseas Food Corporation, Mr. A. J. Wakefield, formerly on the staff of the same organisation, and Mr. Frank Hollins of the Ministry of Food. The Queensland-British Overseas Food Corporation was set up to implement the results of the visit, financed jointly by the U.K. and Queensland governments.

On February 11 last a White Paper issued on behalf of the U.K. and Queensland governments announced in concise terms the arrangements made for winding up this undertaking after four years' operation, the conclusion having been reached that, working under the natural conditions which prevail in the region where the scheme had been sited (the Queensland Central Plain), it is impossible to expect that crops of sorghum can be raised for a figure lower than the return which can be expected for them.

The determining factor is, of course, the uncertain and independable climate. Thus, of the four crops of sorghum raised, the first was damaged by frost, the second by flood and the last two by drought. For the last crop, which was reaped from some 60,000 acres, the average return was at the miserable rate of five bushels per acre.

During the whole course of the scheme the total weight of sorghum grain exported to the U.K. came to 41,223 tons.

It was originally envisaged that the scheme would ultimately include the annual cultivation of 250,000-300,000 acres of sorghum, which it was believed would enable a production of 320,000 pigs. In practice this has been very far from attainment and the total net loss to the two governments in the four years has been £A 880,000.

The decision to abandon the scheme has not been taken without careful deliberation. Last year it was examined by a committee under the chairmanship of Sir John Primrose, which proposed the gradual termination of the project. The Board of the Corporation, after examining the committee's report, however, concluded that there was no evidence for a commercial future for the scheme and recommended its termination in its present form at once.

Some reflections

IT was concluded, however, that the operations have not been without value. The scheme has, for example, shown that sorghum can be grown in the 20-in. rain belt in Queensland and that fatstock can be turned out from this land. The Premier of Queensland, Mr. Gair, is on record as expressing the opinion of that the information gained to an extent outweighs the loss of money, inasmuch as it would be of enormous benefit to Queensland if cattle rearing could be successfully developed in the central region.

The decision has been taken to continue operations on a smaller scale under the sole responsibility of the Queensland Government, for it is considered that a corporation responsible to two governments is not a suitable organisation for carrying out experimental work of this type, a conclusion with which most people with administrative experience of this type of work would agree.

Thus passes yet another example of the operations of the Overseas Food Corporation; it seems to show all the signs that characterised its more extensive and far more costly operations in East Africa, namely, a tendency to 'proceed in a headlong manner,' to quote from one of the Corporation's earlier reports.

To quote from a leading article in the London *Times* of February 12, 'once again we have learnt the folly of plunging into mammoth land development schemes—groundnuts in Tanganyika, poultry in the Gambia and now sorghum in Queensland—without the essential preparation of pilot schemes on a modest scale.'

Repeatedly have we stressed the vital importance of proceeding on lines like this, in these columns. Is it too much to hope that at long last politicians and administrators may begin to learn that in schemes of agricultural development the watchword should always be *festina lente*?

Protein developments

A WEALTH of knowledge about the world's crops still awaits discovery. For example, it has recently been found that two crops of the American continent, teosinte and ramie, are rich protein suppliers. Teosinte is commonly known in Central America and Mexico as the poor man's corn. It is a close relative of maize but has a smaller kernel and an inedible hull. It has long been grown as a cattle food, but its use as human food would seem to have been limited to periods of acute food scarcity. Now, however, research has shown that it contains more protein than maize, and twice as much of the important amino acid, methionine. It is lack of this amino acid in many of the vegetarian or predominantly vegetarian diets of the world that causes malnutrition. If the grain of teosinte is ground, it can be developed for palatable human foodstuffs,

e.g. biscuits. Another possibility, probably more hopeful in the long run, is that crosses of teosinte with maize will produce hybrids that yield a product with higher protein and methionine contents.

Ramie, on the other hand, is a fibre crop; it is a leafy plant giving a tough and versatile fibre and is related to the nettles. Given a high rainfall, a tropical temperature and a fertile soil it grows at an exceptionally rapid rate, as much as 20 in. in 20 days. Ramie has long been grown in China for its fibre, which is used in making China grass cloth. Formerly difficulty occurred in separating the fibre from the gum, in which it is imbedded in the stem, but this has more recently been overcome and it is now grown on some scale in Florida and elsewhere. Immature ramie contains from 18 to 21% of protein, and it has been reported this year that its animal feeding value is also high. Pigs in Central America are fattened on bananas, but there is too little protein pasture or fodder for a sufficient pig population to be raised. Dr. R. L. Squibb, U.S. animal nutritional worker, has tried ramie as a fodder crop for pigs. The pigs rejected both corn and bananas so long as they could continue to eat ramie; indeed, it proved necessary to mix other foods with ramie or to remove it temporarily from the diet in order to ensure balanced feeding. A fibre crop that in earlier stages is a high protein supplier and which can be grown at almost any altitude in tropical climates would seem to deserve attention.

Eelworms and electricity

ROOT knot nematodes are becoming increasingly recognised as an important source of loss wherever crops are grown. Solanaceous crops are particularly liable to damage by them, consequently rather more than ordinary interest would appear to attach to some experimental results obtained recently in connection with tobacco cultivation in Southern Rhodesia, in which attempts were made to control root knot nematodes (*Meloidygne* spp.) attacking tobacco by exposing them to an electrostatic field. The work was carried out at the Tobacco Research Station at Trelawney in Southern Rhodesia by Messrs. R. A. C. Daulton and W. M. Stokes and was reported in the October 1952 issue of the *Empire Journal of Experimental Agriculture*.

Preliminary tests in the greenhouse and on seed beds gave encouraging results and indicated incidentally that electrical fields produced by high frequency alternating currents caused less damage to nematode larvae than fields activated by pulsating direct currents and that, further, the frequency of the pulses appeared to have a direct relation to the destructive effect on the nematodes.

Subsequently experiments on a field scale were undertaken, using a tractor fitted with a 0.5 kw. d.c. shunt wound electric generator, a rotary switch, an induction coil and two insulated electrodes, steel disc electrodes which rotate in light contact with the soil.

Numerous tests were reported to have been carried out with the tractor operating at a speed of 4 m.p.h. on sand veld soil with moisture contents ranging between 2.3% and 9.7%.

Immediately before carrying out tests nematode larvae were introduced into the soil at predetermined distances. It was found that with a distance of 36 in. between the electrodes in dry soil some nematodes survived, but that in moist soil it was possible to increase the electrode spacing to 42 in. and still destroy all nematodes.

It was concluded that equipment of this type was capable of destroying all nematodes, using a frequency of interruption of the electrostatic field of 200 to 700 per sec., while it was also found that tobacco plants in lands subjected to this treatment showed no detrimental effects.

Obviously these results will be subjected to further tests by other workers on other crops in other countries, but they do seem to give grounds for hoping that a new technique may be in process of evolution for dealing with these troublesome pests, which is at once effective and cheap and easy to apply.

The query at once suggests itself to what extent may this technique be applicable to other soil-inhabiting destructive organisms and to what extent is it likely to interfere with the general biological balance of the soil ?

Land tenure among primitive peoples

IN a recent article Lord Hailey has pointed out that in modern times there has seldom been any important social or political change which has not been followed by material modifications of the land tenure system. He suggested that one of the principal problems in Africa at present is to clarify the character of existing native rights in land in Africa and the manner in which these are affected by the threatened break up of existing systems of community land-holding and their substitution by increasing acceptance of different forms of individual tenure.

Many authorities have written on this difficult and intricate subject. C. W. Rowling, adviser on land to the Nigerian Administration, has lately emphasised that in Africa at any rate the law of land tenure is still largely to be found in unwritten tribal custom which varies from area to area, while changes may arise from a variety of causes.

While this is true, it also has to be remembered that it is the outcome of the impact of outside influences, *e.g.* introduction of cash economies in substitution for primitive system of barter, cultivation of cash crops as additions to primitive systems of subsistence agriculture based on shifting cultivation, and above all the fact that, thanks to the colonising powers, the expectation of life of the African native has been greatly extended. This last fact has led to great increases in population density and has made imperative the abandonment of shifting cultivation and the substitution of systems of continuous land use, while the introduction of permanent crops like cocoa has made inacceptable communal land ownership.

It is therefore clear that changing conditions demand that land tenure must be modified to fit them. The need for special study of this subject has long been recognised by the Colonial Office and the recent appointment of an officer in the African Studies Group especially to deal with land tenure questions seems to be a very wise step.

Farming Within the Arctic Circle

FRANK ILLINGWORTH

Member of the American Polar Society, Associate of Arctic Institute of North America

As world populations expand, the eye of man turns inevitably to new regions of the earth to supply the food he needs in ever-increasing quantities. The arctic regions have always seemed to offer very little in the way of inducement to prospective cultivators, but the discovery in these regions of vast mineral wealth has turned attention to the possibility of raising there under favourable conditions a part of the food needed by those engaged in extracting the mineral and forest wealth.

IT is popularly thought that the arctic is desolate and totally beyond cultivation. Yet vast areas offer agricultural opportunities little less marked than those found by the pioneers who struck westwards from the east coast settlements of America two centuries ago. In areas of the arctic where once it was thought nothing could grow, almost the whole range of agricultural produce common to temperate lands is in fact now being grown, and sheep and cattle graze on knee-high clover.

The Ottawa blue book, *Canada's New North West*, states:

'It is known that in Canada's Arctic Mackenzie Valley there are areas of possible arable land that might be cultivated economically in the conditions of scarcity and high freighting costs that exist there . . . In this connection . . . conditions of production that would be impossible in . . . Alberta or Ontario, may represent economic opportunity in the generally arid and barren northlands. It seems safe to assume that there is enough such land in the Mackenzie Valley and other unreported areas to raise the total of estimated cultivable land within Canada's North Pacific Region to a figure of 15,400,000 acres.

'This estimate . . . covers land suited to cropping and excludes grazing and woodlots. . . . It would include farm pasturage where farm cattle may be permitted to run seasonally on fallow lands and, accordingly, would correspond well with the type of land that has in the past been taken up and settled in the Prairie Provinces.

Bearded wheat at the Canadian Agricultural Experimental Station situated at Mile 1016 on the Alaska Highway, Yukon Territory

North Pacific region

'In the (sub-arctic) northwestern part of Canada, beyond the main limits of general settlement, lies a region of over a million square miles, more than one-quarter of the entire area of the Dominion, occupied by little more than one hundred thousand people. This great expanse of mountain, valley, lake and plain, designated the North Pacific Region of Canada, comprises northern British Columbia, most of northern Alberta, the District of Mackenzie and the entire Yukon Territory. Its southern sections, notably the Peace River Valley, contain some of the world's finest agricultural land; its Pacific slope carries some of the finest timber stands on the continent; its mineral wealth, though of great potential importance, remains in large part undeveloped and, over vast areas, virtually unknown.

'Potentially, it is one of the (agriculturally) richest sections of the North American Continent.

'It is fair to assume that as development in the three Prairie Provinces has taken place within the present century, the normal pressure of population will, in the discernible future, operate to bring the agricultural lands in the Northlands to a population density similar to that of the agricultural lands of the Prairie Provinces, with their complementary industries.'

These remarks are equally true of Alaska, Arctic Scandinavia and large areas of the Soviet Union's vast Northlands.

Advantages of arctic conditions

The earth may be free of ice to a depth of perhaps only 12 to 18 in. but it offers advantages unknown to the farmer or smallholder in the temperate latitudes. There are no ground-insect pests; no crop diseases. The soil is not exhausted: in some areas it is as rich as that of Russia's black-loam country. A trader, Charles Clark, who pushed a packet of tomato seeds into the earth at Fort Simpson in the sub-arctic of Canada gathered two buckets-ful of tomatoes of a size calculated to satisfy the most ambitious smallholder in the United Kingdom. Beyond the Polar Circle there is continuous daylight during the three or four summer months and the heat may reach 100° F. in the shade, with

the result that two or three crops of hay and some other types of farm produce can be brought to maturity where the farmers of southern latitudes can raise only one or two. For example, not infrequently Arctic Sweden provides more hay than the rest of the country.

The months-long summer sun encourages abnormal growth. The average weight of a field of cabbages which I saw growing in Canada's sub-Arctic North-West Territories was 9 lb. each, with some exceeding 15 lb.; the circumference of the larger cabbages was such that it was not possible to get one's arms around them, from which it will be possible to imagine the size of the 40-lb. cabbages grown from seed during the short Alaskan summer in the Manatuska Valley.

With the aid of a sheltered valley and the summer sun Soviet agriculturists claim to have grown lemons in the sub-arctic of the U.S.S.R. and last year I saw thick grapes hanging from a large vine against a southern wall in the mining town of Kiruna, 100 miles north of the Polar Circle in Arctic Sweden. In an allotment on the outskirts of this wooden-built, brightly-coloured city in the shadow of the Iron Mountains, I saw tomatoes the size of large apples; I returned to Britain to find the tomatoes in my own back garden not larger than half-a-crown, and the cabbages with hearts the size of a saucer.

The vegetables served in the log-built hotel in Aklavik, in the extreme north of Canada, are grown from seeds in the hotel's own allotment. In 1937 the Dominion Government published a booklet on Canada's Northland, recording that potatoes at Aklavik grow to the size of chickens' eggs, although the ground was frozen from a depth of 6 in.; it also recorded that cabbages were raised at Coppermine, on the very shores of the Polar Ocean. On one small farm in the Mackenzie District of Canada's North-West Territories, clover grows to a height of 4 ft.; barley and oats stand at 30 in. by mid-July, and may be cut before mid-August. Timothy-grass seeds in mid-May; potatoes average 350 bushels to the acre, with a maximum figure of nearer 400 bushels. Although little specific information is as yet available, there are several hundred thousand acres of agricultural land in Canada's Yukon, of which one block in the Dezadeash Valley, crossed by the Alaska Highway, may be mentioned.

Pioneers of arctic agriculture

The first farmers in the arctic were the missionaries who struck up the main waterways leading into unexplored territories. The only means of providing their requirements in vegetables was to include a few packets of seed in their equipment. In some cases the hardest manual labour was necessary for the creation of even a small allotment, because large areas of the North are virtually devoid of soil.

The arrival of the first river steamers in the extreme North of the arctic altered all this. It made the importing of food possible and, instead of growing what they needed, the pioneers turned to easier methods of filling their larders. There was ugency in the air—gold to be mined, fortunes to be made. There was no time for digging allotments, planting seeds and growing vegetables. It did not matter that the cost of importing foodstuffs was prohibitive, for the man who went North saw a fortune in the gold-bearing rocks of the sub-arctic and the arctic. Unlike the missionaries whose lives were to be spent in the North, the majority who struck North intended to stay in the arctic for as short a time as possible, and they had neither the inclination nor the time to grow their requirements of vegetables.

Today, aircraft and tractor-train support the river steamers, providing everything that a community wants, from sticks of celery to sides of beef raised in the agricultural lands perhaps 2,000 miles to the south.

But the pioneer is also conscious that the population of arctic areas now under colonisation can increase annually only in proportion to local agriculture, and there are many examples to prove that agriculture and market gardening are possible in the north on a large scale. For example, a settler in Norman Wells, in the North-West Territories, has raised 23 kinds of vegetables and cereals on the tilled land adjoining his home, some of it for silage and cattle-fodder.

Stock raising

In Aklavik, 100 miles north of the Polar Circle, L. D. Livingstone, local Government Medical Officer, has a highly-successful stock farm. The good doctor imported a cow from Edmonton in 1928, and a bull the following year, and by 1941 his herd had reached double figures.

Cattle mouched through knee-high grass in the neighbourhood of Fort Simpson as long ago as 1851, but Aklavik is further north, and no doubt Livingstone enquired of himself whether cattle raised in temperate lands would survive the cold of the far northern winter, and also whether he would succeed in growing sufficient fodder to last the animals throughout the dark months. Cattle housed in a well-built byre would survive the dark months apparently without any discomfort, and he also discovered that the short and brilliant arctic summer provided sufficient hay to support a herd throughout the winter. In winter he put milk out in shallow pans to freeze for storing, or transport to outlying cabins by 'milk-sledge'; and in summer the lowing of cattle and the cluck of poultry mingle with the roar of a tractor ploughing some 60 acres of newly-transformed agricultural land.

Milk and day length

Unfortunately, the milk supply is inclined to drop steeply when the sun disappears. One of the Norwegian nurses at the hospital at Longyear (the most northerly settlement in the world, 700 miles from the North Pole), told me that by the end of the winter the seven cows in the byre across the valley produced only a trickle of milk. 'Often there isn't anything like enough to provide the minimum requirements of the children here,' she said, 'and they have to make do with tinned and dried milk.'

The Russians have solved the problem of the sun's disappearance so far as milk production is concerned, by installing on experimental farms ultra-violet light plant, powered by windmills driven by the almost constant wind of the polar winter. Some 20 State farms in the Soviet arctic are said to have herds exceeding 100 head of cattle and pigs bred from stock bought in Yorkshire. More than 200 calves have been born in the byres at the Nordiske Experimental Farm, on the 70th Parallel.

Cross breeding for arctic conditions

Both the Russians and the Americans are busy breeding cattle suitable to conditions in the arctic. One such American project is cross-breeding Tibetan Yak with Galloway cattle. The first generation raised on an experimental farm in Alaska showed good form and proved to be good milkers, but the males were sterile, as in the previous bison-cattle 'cross.'

Alaskan conditions

That there is the grazing in Alaska to raise cattle on a large scale is recognised. Indeed, a survey taken shortly after the war indicated that seven thousand square miles of territory in the interior of Alaska were suitable for cattle-raising, and its four-and-a-half million acres of grassland could provide summer feed for 100,000 head of cattle; in addition, there are more than seven million acres of land suitable for growing crops.

Experimental stations

Agriculture in Alaska dates from the Gold Rush days of 1898, since when seven

Making hay in sub-arctic Iceland

experimental stations have been opened, the first at the turn of the century, when it was evident that many men who had made their way to the new gold fields of the North were going to settle in the neighbourhood. Two of these experimental stations are still in operation—in the Matuska Valley and the Tanana Valley, a few miles from Anchorage, where there has not been one crop failure through climatic causes for 46 years. Agricultural scientists are experimenting with hardy grasses and grains, the seed of which came from other northern areas including the northerly parts of Siberia; the experiments include trials with vegetable seed, bush fruit; cereals from the Steppes of Siberia, potatoes from the Andes, wild strawberries from the mountains of British Columbia, alfalfa from Siberia.

American clovers are not sufficiently hardy to survive, but a red clover from Siberia is under trial.

The Matuska Valley came into its own in 1935, when the United States Federal Relief Administration transferred 200 families from the drought-stricken north-west to the virgin forests on the Alaska Railway, near Cook Inlet. Here the new arrivals found a wilderness but, in three years, they transformed it into a typical American farming community. Today, the three main farming localities in Alaska—the Tanana Valley, Matuska Valley, and the Kenai Peninsular—help towards making the surrounding district self-supporting in vegetables, beef and milk.

New cereal and vegetable strains

The new strains of vegetables and cereals are now being grown on an increasingly wide scale throughout Alaska. Fields of alfalfa add a splash of colour to regions which were once thought uncultivable. Areas which 20 years ago were a wilderness of stunted trees and lichen-clad boulders are now yielding potatoes at between 10 and 20 tons per acre. New strains of wheat, barley, oats and winter rye are being grown successfully.

There are extensive areas on the Arctic Circle or beyond it, where cauliflower, carrots, potatoes, cabbages and other vegetables are grown every year, and also hay and corn. For example, barley and oats are raised at Fort Yukon, Wiseman and Shugnak.

It might be thought that the heat of the sun would be insufficient for soft fruits to ripen in the arctic. Yet the writer has seen raspberries and strawberries, gooseberries and currants growing one hundred and more miles north of the Arctic Circle, and an allotment producing the soft fruits associated with market-gardening in the South of England.

Developments in Russia

The Russians were quick to appreciate that the industrial development of their polar areas must depend largely on local-grown produce and from the beginning their aim has been to make the new Northern communities self-supporting. In their endeavours Soviet agriculturists actually went so far as to try to produce a tea-bush able to withstand 28° of frost, and a new species of frost-resistant cotton. They also sent an expedition to the Andes to look for species of frost-resistant wild potatoes which could be crossed with cultivated species to produce tubers capable of withstanding 30° of frost.

As in Canada and Alaska, experimental stations have been established at key points in Arctic Russia. That at Kirovsk covers three thousand acres and the agricultural experiments carried out there have made the growing industrial population of Murmansk almost self-supporting.

Fruit trees at the Norisk Experimental Farm (on the 70th Parallel, in a region subjected to intense winter cold) bear fairly heavy crops, and potatoes, cabbages, onions, carrots and sugar beet are grown out of doors in the summer, while tomatoes and cucumbers are raised in hothouses. In 1942 an experimental sowing of melons yielded an encouraging result, as did 60 acres of oats for cattle fodder.

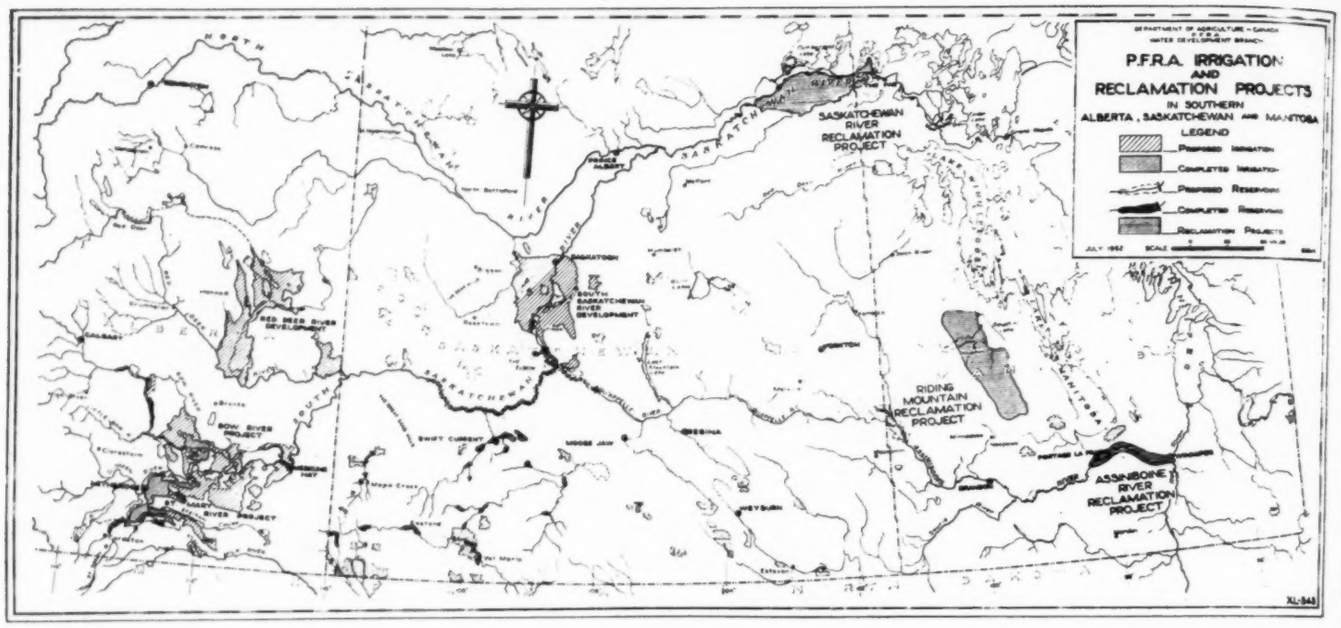
By 1936 the experimental station at Igarka, in one of the most desolate parts of Arctic Siberia, was growing potatoes, cabbages and radishes in the open, and cucumbers, tomatoes, peas and tobacco in hothouses. Hothouses were built as far north as Dixon Island, Novaya Zemlaya and Frans Josef Land, all of which are locked in pack ice for the greater portion of each year.

Conclusion

Many of the examples of agriculture in the arctic contained in the preceding pages concern market gardening and food production on a small scale for small local communities. Nonetheless they also show that food can be grown in the Northlands. Thus, in 1938, Yellowknife, now Canada's leading gold-mining area, was a wilderness of rock and scrub. Today it is a thriving town of 5,000 people, which year by year raises an increasing proportion of its summer requirements of vegetables on land not long ago considered agriculturally useless. In the same way Dr. Livingstone's small 'personal' market garden and farm at Aklavik may one day prove to be the first of many farms in an important agricultural area.

So long as there are market outlets, there will always be an incentive to carry agriculture to the extreme limit of feasibility. Mining and lumbering in remote areas have induced the occupation of lands and the production of crops in conditions and on soils commonly regarded as below marginal. The value of agricultural produce in remote areas and the cost of transport may expand substantially the limit of agricultural opportunity for which there are always seekers. Moreover, the farmer on the fringe has the advantage of cheap land and the practical, if doubtful, advantage of simpler living standards to maintain.

It may be that, with the passage of years, the pressure of demand may force the extension of commercial grazing into the arctic fringe and that the day will come when the Northlands are not only agriculturally self-supporting but contribute to world needs.



Western Canada's Irrigation Schemes

P. A. ROWE

'THE Hungry Thirties,' when drought year followed drought year on the Canadian prairies, not only taught Canada the importance of prairie farms in the national economy but also focused attention on the need for irrigation in the vast grain-growing belt of the western provinces of Manitoba, Saskatchewan and Alberta.

How sadly irrigation had been neglected in western Canada may be appreciated from the fact that even now, after considerable work has been carried out in the intervening period, Alberta has only 700,000 acres under irrigation, Saskatchewan 75,000 acres, and Manitoba 300 acres! This compares with more than 20,000,000 irrigated acres in 17 agricultural states of the U.S.A.

Early schemes

Until the 1930s no Canadian government had backed irrigation schemes on a large scale. Then, in 1936, a start was made with a comparatively small scheme of aiding the construction of individual irrigation projects, dug-outs and stock-watering dams initiated by the farmers themselves. During the 16 years since this scheme was evolved, the Dominion government has spent $5,500,000 on minor projects on which the farmers have spent about $15,000,000. More than 65,000 farmers have been assisted by this plan.

The importance of the prairies of Western Canada to the world's wheat supplies is very great. Hitherto, a difficulty has been their liability to drought and the consequent uncertain nature of the harvest in some localities. To remedy this the Canadian Government is now embarking on a number of large-scale irrigation projects, described in this article.

Post-war developments

During the Second World War, governmental plans for any major irrigation projects had to be shelved because of shortages of manpower and materials, but immediately hostilities ceased the Dominion government announced plans to spend $275,000,000 in western Canada in a three-way partnership to defeat drought by irrigation. The other partners were to be the provincial governments of Alberta, Saskatchewan and Manitoba; and the farmers, through their organisations.

The programme was to be administered by the Prairie Farm Rehabilitation Administration, a government agency established in 1935, and envisaged irrigation of more than 3,000,000 acres. Each year since the war the Canadian government has appropriated substantial moneys for this programme. In the 1952-53 fiscal year, its appropriation will amount to about $7,000,000, and it is expected that the federal appropriations for the next ten years will exceed $110,000,000.

The three-way programme features four major irrigation projects, which alone will account for an expenditure of $220,000,000. These are:

1. The St. Mary-Milk Rivers Development in south-west Alberta.
2. The Bow River Development in southern Alberta.
3. The South Saskatchewan Development in central Saskatchewan.
4. The Red Deer Development in eastern Alberta.

St. Mary-Milk Rivers project

The St. Mary-Milk Rivers project will ultimately cost $40,000,000 and will place 400,000 acres of land in fertile districts under irrigation. These sweep eastwards from Lethbridge for 100 miles and also south-eastward from Lethbridge for over 60 miles. The project, in which water distribution systems for 60,000 acres were completed during 1952, has absorbed and will continue to serve 120,000 acres previously under irrigation.

The key structure in this project is the

St. Mary River dam, which was started in October 1945. This $7,000,000 structure, built 26 miles south-west of Lethbridge, was officially opened in 1951 by Canada's agricultural minister, the Hon. James Gardiner. Built with more than four million cu. yd. of material, the dam rises 202 ft. above its foundations, while its crest is 2,630 ft. long. This makes it the biggest and highest earthen dam built in Canada.

By damming the river, the structure forms a reservoir 18 miles long, six miles wide and 173 ft. deep, in which can be stored 320,000 acre-ft. of water.

The precipitation in the area to be served by this dam is only about 12 in. a year. This means that farmers formerly have had to farm more than a thousand acres to eke out an existence. As short grass rangelands, these areas have only produced an average of 250 lb. of beef annually on every 60 acres. The completion of the project will result in the establishment of about 3,000 new irrigated farms in southern Alberta. They will be allocated to farmers in drought-ridden areas of the prairie provinces who have repeatedly required government aid because of crop failures.

Agricultural officials maintain that if the new irrigated land is used for nothing more than good pasturage for beef cattle, the land will produce new wealth at a rate of between $150 and $400 per acre annually. Actually, much of the land will be used for growing sugar beet, vegetables for canning, small fruits and other specialised crops, so that the new wealth gained will be much greater. Even the most cautious officials believe the new land brought under irrigation by the St. Mary River dam will increase Alberta's annual agricultural production by $50,000,000. They expect new food processing plants and other secondary industries to develop in the area served shortly after the land is under cultivation.

Strip farming south of Lethbridge; also showing St. Mary's River dam irrigation canal

Nearly two-thirds of the necessary work related to this dam has now been completed. This includes construction of works to divert the water running off the land from thawed snow each spring to the reservoir, and the canals and other means of putting the water on the farmers' land.

Although essentially an irrigation project, the St. Mary-Milk Rivers Development can be equipped with three hydro-electric plants capable of producing an annual energy output of 71,000,000 kilowatt hours. These will be necessary as the rural demand for electrical power grows in southern Alberta.

Bassalo irrigation dam, Bassalo, Alberta

Bow River scheme

The Bow River Development is being completed north-east of Lethbridge by the Canadian government to increase the existing irrigated acreage from 57,000 to 240,000 acres. The system was formerly owned and operated by the British-owned Canada Land and Irrigation Company. It was purchased in 1949 by the Canadian government for $2,250,000. Earlier, the British company had spent about $20,000,000 on the project as a land colonisation scheme. Overall costs to renovate and expand the project will be between $17,000,000 and $20,000,000. When this expansion is completed, about 1,400 new farms will be irrigated. Roughly 15,000 acres were placed under irrigation by this project in 1952.

South Saskatchewan scheme

The South Saskatchewan River Development will serve 500,000 acres surrounding the city of Saskatoon for many miles. This is an area where prolonged droughts have created serious economic problems for 50,000 farmers.

Work on the main dam, which would be the keystone of the scheme, has still to be started. Costing at least $75,000,000, it

Irrigated sugar beet in the Lethbridge area of Alberta

would take ten years to build. One and a half miles long and 210 ft. high, the earth dam would hold back a lake 35 miles long and 180 ft. deep. Power installations on this project would produce 435,000,000 kilowatt hours per year and bring Saskatchewan, whose economy has hitherto been based primarily on wheat, excellent opportunities for industrialisation.

The Red Deer project

Finally, the Red Deer project, a scheme which is still being investigated and planned, would make 500,000 acres irrigable in east-central Alberta and would include power installations producing 75,000,000 kilowatt hours of electricity annually.

Further developments

While these specific projects are under way or being planned, federal and provincial government investigations are also being made into even grander-scale methods of eliminating the drought conditions on the prairies. One of these is the consideration of the feasibility of diverting the Athabaska and North Saskatchewan Rivers to the southerly, fertile prairies.

In addition, as Dr. L. B. Thomson, Director of the Prairie Farm Rehabilitation Administration, has noted, a reclamation programme to meet the problems of water erosion and flood control will have to be developed hand-in-hand with irrigation development if the land resources of Western Canada are to be used to the full.

The potentialities of the prairie lands of Western Canada, once reliable irrigation water supplies are available, are very great indeed. The future looks bright, provided further developments continue to be carried out.

Photos: Agent General for Alberta, London

India Studies Fertiliser Production

A team of Indian officials are reported to be visiting some countries to study processes of fertiliser manufacture as the result of the Technical Assistance Agreement with the United States of America signed in New Delhi on February 9. For this purpose the Government of the U.S.A. will make available to India a sum not exceeding 10,000 dollars. Under the agreement, three Indian officials selected by the Indian Government from those connected with the development of fertiliser production in India will be sent to Europe, North America and Japan to study and observe the ammonium nitrate manufacturing processes in those countries with a view to selecting the type of process and facilities suitable to conditions in India. The project is in connection with the proposed expansion of the Sindri fertiliser plant.

The U.S. Technical Co-operation Administration will arrange for one specialist in fertiliser production from outside India to accompany and assist the Indian officials.

American Farm Produce Barter Plan

A *Reuter* report from Washington reports that the United States Agriculture Department is actively studying a new plan to barter surplus American farm products for foreign manufactured goods. The exchange would be made through normal commercial trade channels and not on a government-to-government basis.

Described by its sponsors as a ' gateway through the tariff wall ' the plan had the bipartisan support of Congressmen from wheat, cotton and tobacco States, who were worried about falling prices and shrinking overseas markets.

Legislation which would put the plan into operation is being prepared for Congressional approval. But it is expected to run into opposition from manufacturing interests, who foresee possibilities of increased competition from imports.

Briefly the idea is that European and other nations needing farm products could get them from the U.S. in exchange for manufactured goods like machinery, cutlery, leatherware or other articles on which they would receive a ' tariff bonus ' to encourage the trade. The plan would provide for tariff reductions on certain imports if such tariffs were now so high as to prevent a foreign exporter from shipping to the U.S., provided that American farm products were accepted in return in the private barter arrangements.

The tariff bonus would only apply to transactions under which a foreign trader agreed to accept the farm produce in return for the manufactured goods.

It was the hope of the plan's Congressional sponsors that the Department of Agriculture would accept the plan and present it to Congress as a Department bill. But if the Department did not, then a group of southern and mid-western Congressmen would introduce their own measure, it was said.

Tree Growing and Forestry in Morocco

C. H. BROWN, B.Sc.

In this article, Mr. C. H. Brown, who will be well known to our readers as the author of a number of papers which have already appeared in WORLD CROPS, *records his impressions of the need for and possibilities of reafforestation in Morocco.*

THE immense tracts of alluvial plain lying between the Atlas mountains and the sea would appear to bear witness to a distant past in Morocco much better than now. There seems every reason to suppose that when these plains were laid down the whole of the region was much more heavily wooded than it is today. The bleak dry plateaux which separate the plains from one another may also have carried forests in days of heavier rainfall.

These are matters of speculation, but what seems certain is that the whole of Morocco appears to be eminently suitable for an intense reafforestation programme which would be a direct source of wealth, and help indirectly perhaps by increasing the scanty rainfall. It is unfortunate that the more urgent requirements of roads, irrigation and industrial development leave very little financial margin for the government to give to this question the close attention it deserves. But on a small scale it is being studied.

The Atlas mountains

The wooded ranges of the Atlas themselves are almost certainly the best evidence of what is possible. Even here, however, well-timbered slopes alternate with much bare escarpment which would seem equally suitable for the growth of trees. The limiting factor is perhaps here, as in so many other countries, the ubiquitous goat of the Berber villagers. Genuine forests do survive, the most notable being the cedar forest at the northern end of the Middle Atlas. These are the main source of timber for the whole of Morocco. Below these cedars, and the southern end of the Atlas ranges, the commonest trees are the Aleppo pine (*Pinus halepensis*) and the evergreen or holm oak (*Quercus ilex*). The latter predominates below about 4,000 ft., and the former above it. Neither has any important economic use except as a source of fuel, but even for this purpose they would appear to justify active encouragement. There is room for double or more the present tree population, at heights above those which are suitable for olives and apricots, the main crop trees of the Atlas foothills.

Typical cedar forest on the slopes of the Middle Atlas

Cork oaks and arganus

Off the Atlas mountains Morocco carries only two naturally surviving forest trees. The most important is the cork oak (*Quercus lusitanicus*) which is found in patches near the sea, more particularly in the north-western region, inland of Rabat and Port Lyautey. The cork is not of the same high quality as that of Portuguese growing, but its exploitation forms a worthwhile minor industry.

More as a botanic curiosity than because of its economic importance, the forest of 'arganici' (*Arganus* sp.) on the south-western seaboard, between Agadin and Mogador, is worth a mention. It appears to be the only region in the world where this curious tree is found. An oil is extracted locally from its seeds, and its leaves have a pasturage value to the local goat-herds, the goats perilously climbing into the branches. In the northern part of this region Thuya, mixed with the arganier, provides wood for the cabinet makers of Mogador.

Eucalyptus

The dominant tree of the foreign importations is the eucalyptus. In Morocco, as in Egypt, it is now the favourite tree for roadside planting, *Ficus nitrida* filling the same role for the towns. Eucalyptus is now spreading throughout the semi-tropical world. It is a quick grower, though its wood is of little value. In the north-western corner of French Morocco, on a low plain east of Port Lyautey, an

experiment is being made in the extensive planting of eucalyptus to provide wood pulp for a local paper industry.

The Moroccan plains

The fertile soil of the Moroccan plains is reserved for the large-scale growth of irrigated crops in future; close-planted cypresses as a windbreak are an attractive feature of the few areas so far developed. It is on these plateaux and the chains of minor hills which break them up, that the real afforestation possibilities seem to lie. The best of them carry good crops of wheat, but the bleaker parts cry out to be used. The planting of trees here can be looked on from the three points of view of the provision of timber, the prevention of erosion, and the amelioration of the climate. The latter might follow automatically if enough trees could be successfully planted; they would thrive in the extra rainfall which their presence helps to create. The first two ideas are already the subject of such limited experiments as the budget allows.

The outlook

For straightforward afforestation either the Aleppo pine, eucalyptus, or a mixture of the two are being used, while the possibilities of the successful establishment of prickly pear (*Opuntia* spp.) are also being studied. Terracing for erosion control also allows of the accumulation of enough water on the terraces to establish fig and olive trees. These are long-term experiments, as all such adventures with trees must be. But the possibilities are clear and it is an immense pity that resources do not allow them to be tested on a much wider scale.

Well established cedars in the Khenifra area of the Middle Atlas

The Work of the Empire Cotton Growing Corporation

THIS year the Empire Cotton Growing Corporation have departed from their usual custom of publishing the annual reports on the work carried out at the various experiment stations under their charge in one annual volume and have issued them as a series of separate brochures* dealing with particular undertakings or particular territories.

The full series comprises 12 reports and of these we have so far received four dealing with work at the Central Research Station at Namulonge in Uganda, in Nyasaland, the Sudan and Aden.

Particular interest, of course, centres on the Namulonge reports, which indicate that the station has now got well into its stride, while the major building programme was brought to an end with the completion of the staff quarters and the last of the working buildings.

68 acres of cotton were grown, and 87 acres were planted under food crops.

Of the other reports, that for Nyasaland shows that the decision of the Government to apply summer cropping practice to the whole of the Southern Province, thus bringing it and the Central Province under one regime, has had excellent results, and despite the none too favourable rainy season good yields were obtained in all localities and an improvement in lint quality was recorded.

In the Sudan the work on cotton breeding has continued to be carried on under the Corporation's plant breeders. Mr. R. R. Anson relinquished his post of chief cotton breeder in order to take up work in Aden. A major change in policy occurred during the year, inasmuch as it was decided to work on derivatives from Domains Sakel and X1730A at the Medani station in alternate years in order to avoid the limitation arising from selection in continuously self-bred material, in breeding work which essentially consists in building up minor gene complexes which may or may not be superimposed upon a major gene.

Aden represents a comparatively new sphere of work for the Corporation, due to the decision to develop the Abyan scheme which aims at building up a cotton industry based on an area where previously nothing was grown owing to blood feuds between rival tribes inhabiting the area, notwithstanding that possibilities of irrigation had long been known to exist.

The system of irrigation is that of flooding and depends on utilising the water of local rivers which come down in flood once a year, conditions resembling in this regard those which prevail in the Gash and Tokar areas in the Sudan.

The scheme itself depends on growing food crops such as durra (sorghum) and sesame in conjunction with cotton as a cash crop. The seed used was imported from the Sudan in the first place in 1949, the Sudan Egyptian variety X1730A being used. In 1952, 9,000 acres were planted in cotton. The total irrigable area in this locality is estimated to be 100,000 acres and already the efforts made have had considerable success in improving conditions in this area.

A cotton experiment station has been started by the Corporation, the work of which is directed to testing new imported varieties of cotton and improving existing strains by breeding and selection.

**Progress Reports from Experiment Stations for 1951-52.* Pp. 68 (in four separate reports). London, 1952.

Willows – A Valuable Genus

DONALD MULLINS

Its numerous industrial uses make the willow one of our most serviceable trees. Methods of cultivation and processing are outlined in the following article.

THE willow, genus *Salix*, has long been universally used for making such essential articles as hurdles and baskets; wicker-work fragments were unearthed from the Glastonbury Lake village of 100 B.C. There is, in fact, evidence that the early potter, lacking the facilities of a wheel, contrived to shape his clay to a mould of woven osiers. The usefulness of the plant has in no wise diminished with the increasing complexity of modern industry and it is widely grown in Britain, Belgium, Holland, France, Germany, Poland, etc. Cultivation in the U.K. is carried on largely in the valleys of the Trent, Thames and Parrett, in the counties of Nottingham, Leicester, Lancashire, Lincoln, Cambridge, Worcester, Gloucester, Huntingdon, Somerset and Berkshire and in East Anglia. There are some 50 varieties in existence in two main species, *S. triandra* (Black Maul, Black Spaniard, Stone Rod, Champion Rod, Glibskins) and *S. viminalis* (Mealy Top, Brown Merrin, Yellow Osier), corresponding to ' hard ' and ' soft ' respectively in growers' nomenclature with reference to pliability. A third species, *S. purpurea*, characterised by its bitter taste and the yellow tint on the inside of its bark, includes the famous Dicky Meadowes (named after the Mawdesley grower who first raised it in the U.K.). This variety produces a very slender rod, used for making knife basket partitions, tying celery, etc. Its spreading habit, however, makes it difficult to harvest, as the butts have a pronounced curve, especially for the first two years. Willow barks in general provide a source of the glucoside, salicin, ($C_{13}H_{18}O_7$), a valuable tonic and antidote for rheumatic fever.

Drainage essential

Willows are widely tolerant to soil, but favour a rich, well-drained loam; peaty land is unsatisfactory. Although occasional inundations are beneficial, it is of the utmost importance that there should be adequate drainage, preferably effected by trenching, as pipes soon become choked with root fibres. Despite their luxuriant growth, willows are not soil robbers. The prolific leaf fall provides fertilising humus and beds are sometimes kept in continuous crop for anything from 12 to 30 years. Wind and frost are both unfavourable factors.

Propagation is carried out by the use of cuttings or ' setts.' These are made in 13-in. lengths from healthy two-year-old wood. With butts trimmed to an angle and tops cut square just above a bud, the setts are thrust deep into the soil, the planter's palm being protected by a leather shield. About 1 in. only is left exposed to ensure that the future head will be near ground level, remaining unloosened by powerful winds. Planting may be effected from November to April, 12 ft. apart in 18-in. rows, at the rate of 20,000 per acre (autumn planting, however, may possibly result in the setts being ' lifted ' by frost, necessitating subsequent firming). Some growers prefer to use land which has been summer fallowed prior to being well worked to a depth of 10 in.

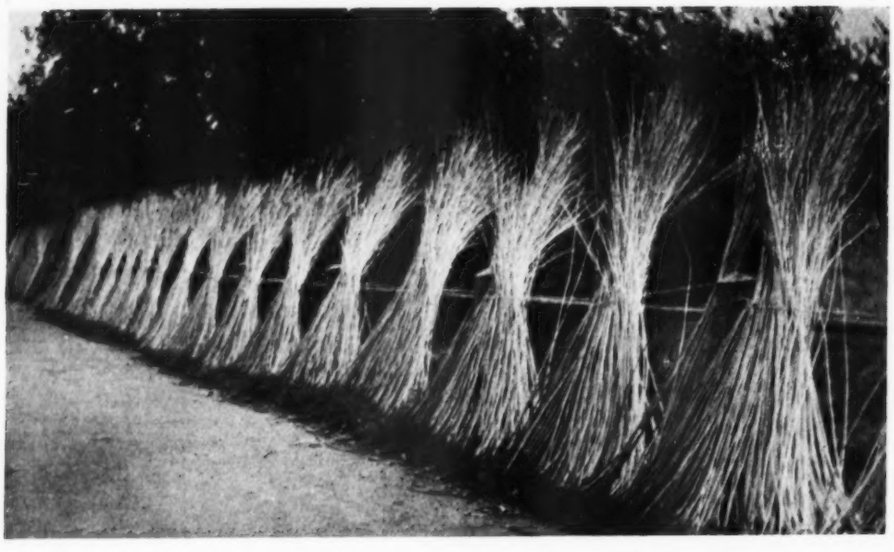
At work on an open-ended log basket

It is important to keep down weeds in the early stages, either by ' cleaning ' with a hook or by hoeing in April, May and July. Growth is accelerated by hot, dry weather, when it may amount to as much as 1 in. per day. The maiden crop is of little value; opinions appear to vary as to the advisability of cutting it. Harvesting may be carried on after leaf fall in November or in spring. In the latter event, watch is kept for the first leaves or catkins and the rods are cut as the sap flow begins, so that they can be ' whitened off the stock ' (*i.e.* peeled straight away). If left too long they depreciate through the development of a second skin; late cutting also tends to ' bleed ' the head. Cutting is done with a hook, the stroke being upward and inward, close to the head. The rods are then tied with withy bonds into bundles or ' bolts ' having a girth of 3 ft. measured about 3 in. from the butt, or in half-bolt ' wads.' A cutter will average some 40 bundles a day and the crop usually amounts to some 100 bolts per acre (equal to 1½ to 7 tons, varying according to moisture content, etc.). Allowing for subsequent culling, about 70 bolts will be left after sorting and 60 after finishing.

Peeling

The inferior rods only, known as ' brown stuff,' are sold unpeeled for use in the coarser types of work, such as making yeast baskets, etc. All remain in a naturally peelable condition for some four to 14 days after cutting. Peeling makes the rods waterproof and more durable; it was formerly carried out by drawing them through a V-shaped ' brake,' consisting of two iron blades held at correct tension by the free hand. The method had its disadvantages: only a highly-skilled blacksmith could turn out a satisfactory brake and inexpert peelers would split the rods by applying undue pressure. It has been superseded by the use of a mechanical device consisting of numerous Y-shaped rods, about 2½ in. in length and of ¼-in. gauge, affixed to cross-bars mounted in a revolving drum powered by a small petrol engine or electric motor. By this means damage can be reduced to a minimum. After peeling, the rods are dried out of doors for some 24 hours.

A great strain would obviously be placed on available labour resources if the entire crop had to be processed within the 14 days from harvest; three methods are therefore employed to enable the rods to be dealt with at leisure. ' Couching ' consists of piling the bundles six deep on rotted straw, butts facing opposite ways in alternate rows. The heap is then covered with rotted peelings and watered occasionally so that sap flow is maintained in a ' sweaty ' atmosphere, the tops having been left ventilated. ' Pieing ' is a similar procedure, differing only in the manner of making the heap. Both methods provide a supply of rods for peeling, to follow those



Buffed rods drying off in the sun—a familiar roadside scene in willow country

treated ' off the head.' The third method, ' pitting,' is the one most widely employed. The bundles are placed butts downward in rhines containing about 8 in. of water, which must be circulating, as stagnation results in deterioration of the rods. ' Leafing out ' will eventually take place and the rods will remain in peelable condition until July (no ' double-skin ' growth being produced).

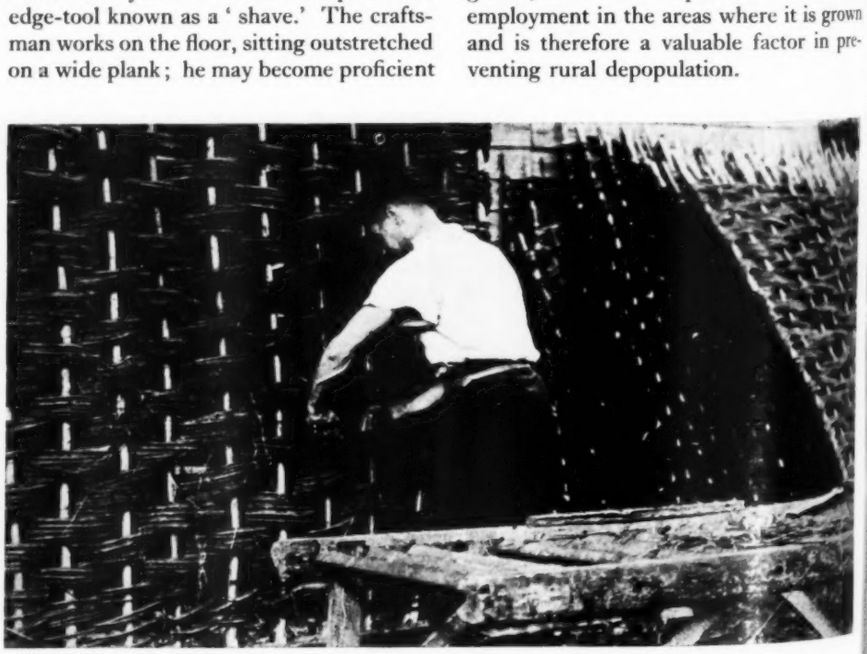
' Buffing ' by boiling

' Buffing ' is designed to turn the rods from the natural white to buff colour and is carried out in the autumn. Bundles of unpeeled rods (which may be either freshly cut or dry) are placed in a large oblong tank, built over a flue and having a tall chimney at one end, and boiled for eight hours. By this means the tannin from the bark is made to penetrate the wood, giving it a pleasing buff tint (or black in the case of Dicky Meadowes). Peeling is best undertaken immediately, though it may be delayed for a week if the rods are kept covered. After peeling, they are exposed to sun and air, whereby the colour is enhanced. The peelings, boiled or fresh, can be made into a useful fertiliser for tomatoes, celery, etc., if heaped and rotted down for 12 months.

Baskets and hurdles

The dried rods are sorted into various sizes, from 3 ft. to 7 ft., bundled and stored under cover until required. The stouter grades are known as ' sticks '; they may be cut either as two-year growths from the beds or from pollarded trees, the latter providing the harder wood. Making up into baskets and hurdles sometimes takes place on the plantation itself, though many growers produce for sale only. The rods are soaked for a few hours before use to increase their flexibility. Few and simple tools are required: some bodkins, a ' picking knife,' a short, thick blade with a bulbous handle used to trim off surplus wood with a *pushing* action, and a ' commander,' a flat 1-ft. metal bar having a large eye at one end. This beats the interwoven wicker-work tightly into place on the ' stick ' frame, the eye being used to straighten bent material. There is also a boxwood ' cleaver ' with three metal flanges used to split the rods into sections or ' skeins ' when such are needed; the pith is scooped out of the skein and its surface smoothed by means of a small plane-like edge-tool known as a ' shave.' The craftsman works on the floor, sitting outstretched on a wide plank; he may become proficient after about three years. The expert, however, is continually acquiring new aptitudes owing to the variety of his work, which actually comprises at least six different crafts, chairs, baskets, etc. Reliance is placed mainly on the eye alone, calling for a nicety of judgment which is unnecessary when measurements are used. Working the rod singly is known as ' randing,' using several at a time is ' slewing,' while ' fitching ' is working with two rods twisted around one another where strong open runs are required, as in poultry hampers.

The making of hurdles for fencing provides another outlet for ' brown stuff '; if creosoted they can be sold with a seven-year guarantee, though they will last for as many as 20 years if left undisturbed. An expert hurdler will make up to a dozen a day, the skeleton of ' sticks ' being held upright by insertion in a baulk of timber. Spar-gads (from A.S. *gád*—goad), for thatching either ricks or houses, are also made from coarse green willow sticks. The craftsman first splits them in half, in lengths of about 2 ft. 6 in., with a small bill-hook, after which he points each end using three strokes only. He then twists the half-section on his knee, which is protected by a leather pad, making two separate turns, so that when the finished spar is doubled together a 1-in. bridge will be left at the top. Immediate bundling ensures that the spars will retain their hairpin shape as they dry out. Other rural uses for willow are for making hay-rakes and for the snaiths or handles of scythes, which are nowadays bent to the correct curves by steam-heating. Altogether, the willow provides substantial employment in the areas where it is grown and is therefore a valuable factor in preventing rural depopulation.



Trimming a completed hurdle at Stoke St. Gregory, Somerset

Bat willows, near maturity, growing on a sewage farm

Pests and diseases

Willows in commercial cultivation are prone to attack by insect pests—and by rabbits. In addition to the familiar greenfly, there is the sap-sucking willow aphid, which eventually destroys the rod after coating it with secreted 'honey-dew.' Another menace is the willow weevil (*Cryptorrhyncus lapathi*), commonly called an 'elephant' on account of its proboscis, which it thrusts into the soft part of the rod, leaving a mark known as 'black spot.' The weakened osier then bends to the wind and also develops a warty growth which prevents satisfactory peeling. The weevil itself is said to emit a crying sound when picked up: its larvae do further harm by burrowing into the heads. Gall-midges (*C. cecidomyia* and *C. rosaria*) will damage the osier-tips, stopping growth and causing 'leach' or 'button-top.' Willow-moth larvae also form leaf-nests at the tips, which are then eaten away, leading to outgrowths called 'bushy top.' Some of these various pests can be controlled by spraying, the once-favoured nicotine and soapsuds now being superseded by miscible DDT.

Shoot control

Some growers also make a practice of removing the first shoots from the stool when about 3 in. long, holding that the later growths, developing towards May, are more resistant to pests and diseases. This was formerly done with a hook, but it has now been found that a tar-oil spray is equally effective; it also serves a dual purpose in destroying weeds.

Bat willows

Another valuable species of willow is *S. coerulea*, the blue or bat willow. Its timber, particularly in the female tree, combines lightness with a degree of toughness so extreme as to make it practically unsplinterable. It is therefore utilised for making cricket bats and for artificial limbs (for which purpose its non-liability to white-ant damage offers another advantage). Not readily catching fire by friction, it is often used for brake blocks; its water-resisting properties also make it eminently suitable for water-wheels, paddles, etc. It is now widely grown on sewage farms, where it provides a valuable source of revenue, which may amount to as much as 1s. 6d. in the £ on the levied rate. Maturing quickly within 9 to 15 years, the trees are about 4 ft. in girth and up to 75 ft. in height when they are felled, after which they are peeled prior to disposal. The species favours good, well-drained soil with access to plenty of water—such as may be found near streams. It is propagated by inserting 9-ft. setts into the ground to a depth of 7 ft., some 24 ft. apart, at 75 per acre—all side-buds being carefully removed as soon as they can be seen developing.

Southern Rhodesia's 'Royal'

Earl Fortescue, K.G., as the representative of the Royal Agricultural Society of England will open the 1953 Show of the Royal Agricultural Society of Southern Rhodesia at Bulawayo next September. Lord Fortescue is a member of the Council of the R.A.S.E. and was President in 1952.

Aldrin and Dieldrin

Aldrin has now been granted official label acceptance for control of wireworms on Irish potatoes by the United States Department of Agriculture.

F. W. Hatch, Manager of the Julius Hyman and Co. Division of Shell Chemical Corporation reports that tests made during the past four years in all major potato-growing areas in the United States established aldrin's effectiveness against wireworm and show it to be one of the most economical methods of wireworm control yet developed.

Mr. Hatch also announced recently that Alfalfa (lucerne) yields have been increased by as much as one ton per acre through weevil control, using dieldrin as the insecticide. Dieldrin was accepted last year by the U.S.D.A. for adult alfalfa weevil control.

He referred to the work conducted during the past four years by insect control authorities. 'The best, easiest and cheapest way to control the alfalfa weevil is to destroy it in the adult stage before it lays its eggs. Dieldrin at four oz. to the acre has proved the most effective compound, and at this rate of application pays for itself in increased yields many times over.'

Alfalfa should be treated at the first indication that warm weather is approaching. To wait until the new green foliage is more than an inch tall is to give the adult weevil a chance to lay eggs, and then it is too late to prevent the larvae from feeding on the crowns and tips of the young plants. If the weevil is killed, there are no larvae, and the chance for a large first crop and good subsequent cuttings is substantially increased.

Technical News

In the current (April) issue of *Food Manufacture*, F. A. Robinson writes on the vitamins industry and its progress in 1953.

In *Manufacturing Chemist* there is an article entitled 'Chemotherapeutic Control of Piroplasmosis' by F. G. Hobart, Ph.C. —Modern Veterinary Medicaments (3). Also in this issue are Progress Reports on Fertilisers.

'The Manufacture of High Tenacity Viscous Rayon' is the title of an article in this month's *Fibres* (*Natural and Synthetic*). April contents of *Chemical and Process Engineering* include Demineralisation of Salt Waters, Utilisation of Solar Energy and World Chemical Industrial Expansion.

In the *Muck Shifter and Public Works Digest* this month there is included an article on the reclamation scheme at Beauly Firth in Scotland.

The Cultivation of Rice in Egypt

THE cultivation of rice in Egypt has shown rapid development in the last 25 years. Since 1939 special reasons have favoured the extension of the acreage under this crop. The reduction of the cotton acreages imposed by the Egyptian Government during the war led to increased acreages for other summer crops, and in particular for rice. Before the last war the cotton acreage was about 20% of the total cultivated area. Between 1942 and 1944 this figure fell to 8%, and in 1947 rose to 13%. For rice, the figure for the years 1935-39 was 5.5%, for 1942-44 7%, for 1947 8% of the total cultivated area. The cultivation of rice spread gradually through all the northern half of the Nile Delta, and it came to be grown not merely to counteract the salinity of the soil, for which it had been cultivated earlier, but as a cash crop to be grown on good land.

For some years the Egyptian Government has requisitioned a part of the rice harvest at £E 17 the dariba.* In 1939 the price of rice was £E 5 the dariba. The cultivation of this crop has therefore become quite remunerative.

TABLE 1

VALUE OF PRINCIPAL EGYPTIAN AGRICULTURAL PRODUCTS

	1939 £E 000	1945 £E 000
Cotton ..	29,406	42,571
Wheat ..	12,058	31,366
Maize ..	10,257	31,886
Rice	5,436	14,669

Development of rice growing

Tables 2, 3 and 4 show how the yield of rice has increased since 1920 faster than the acreage.

TABLE 2

RICE ACREAGE IN FEDDANS*

Average of	
1920-24	189,000
1925-29	271,000
1930-34	339,000
1935-39	446,000
1940-44	578,000
1945	630,000
1946	632,000
1947	776,000
1948	786,000

* A feddan = 1,038 acres.

TABLE 3

RICE YIELD IN DARIBAS

Average of	
1920-24	232,000
1925-29	376,000
1930-34	454,000
1935-39	724,000
1940-44	779,000
1945	917,000
1946	993,000
1947	1,351,000
1948	1,384,000

* A dariba of paddy rice = 945 kg. = 2,084 lb.

Of late years rice growing has extended considerably in Egypt; the following article gives an account of the present position of rice growing in that country.

TABLE 4

AVERAGE YIELD PER FEDDAN IN DARIBAS

1920-24	1.23
1925-29	1.39
1930-34	1.34
1935-39	1.62
1940-44	1.35
1945	1.45
1946	1.57
1947	1.74
1948	1.76

	%
White rice, including large and medium broken grains ..	67.5
Small and fine broken grains ..	2.7
Bran	9.3
Seed	1.0
Husks	19.5
	100.0

This marked increase in yield is due to improved methods of cultivation, better selection of plants, more copious use of fertilisers, and increase in supplies of water for irrigation.

The cultivation of rice is mainly confined to Lower Egypt, and particularly to the northern provinces of Gharbieh, Behera, Dakahlieh and Charkieh. In these provinces 95.2% of Egypt's rice crop is grown. Fayoum in Middle Egypt contributes 3.1% grown during the Nile flood season. No rice is grown in Upper Egypt.

Yields

The average yield per feddan in Lower Egypt is 1.77 daribas, though on the fertile lands of Dakahlieh, Menoufieh and Kalioubieh yields of up to 2 daribas are obtained. In the Fayoum the yield is 0.89 daribas.

In the course of the ten years 1939 to 1949, during which the rice crop has become more remunerative, it has pushed its way further south. Here it is soon likely to meet competition from the profitable cotton. But it is possible that the acreage may be increased still further, particularly where, as in Gharbieh province, more areas of saline soil are being brought under cultivation.

The soil of Egypt is well suited to the cultivation of rice. If fertilisers are used to supplement the shortage of certain nutritive elements, yields can be obtained which are higher than those of the great rice-producing countries.

It has been said that rice 'puts its feet in the water, but keeps its head in the sun.' It makes heavy demands on the supply of irrigation water. This explains why formerly the cultivation of rice was forbidden in years when the flood waters were low. For full growth, over a period of 150 days with irrigation on 135 days, one feddan needs about 7,000 cu. metres of water. This is much more than is needed for cotton. Here is the reason why the growing of rice is limited to Lower Egypt and the Fayoum. The perennial irrigation in use in these areas provides sufficient water, but the basin irrigation of Upper Egypt, even when supplemented by artesian wells, has not sufficient resources to grow a rice crop. Any future extension of the rice acreage is dependent therefore on increases in reserves of water.

Varieties

A great many varieties of rice are grown in Egypt at the present time. The most important are:

1. *Japanese varieties or El Yabani.* These have been developed locally into strains particularly suited to Egypt. React badly to saline soil. Growing season 130-150 days; yield about 68% of white rice.

2. *El Nabatat varieties.* Developed from Persian strains. Growing season 150-160 days. Can grow in saline soil. Yield 61.5% of white rice and 27.5% of husk.

3. *El Fino.* A late variety. Growing season 180-200 days. Can grow in saline soil. Yield after blanching is not so high as 1 and 2 above.

4. *El Sabaïni.* Early variety. Growing season 85-100 days. Also called El Fayoumi, because it is very much grown in the Fayoum. Yield in white rice is not so high as 1 and 2 above. Its short growing season fits it particularly for use during the Nile flood.

The Egyptian Ministry of Agriculture has developed various cross-breeds from these varieties and is constantly experimenting to develop plants best suited to Egyptian conditions.

Many other varieties, which are gradually disappearing, are still grown on saline soils. Among these may be mentioned:

5. *El Sultani.* Late variety. Growing season 200 days. Poor yield, but excellent culinary qualities.

6. *El Iraki.* Japanese in origin, imported into Iraq and then to Egypt. Lower yield than El Yabani.

7. *El Debi.* Selected from El Iraki and suitable for the Fayoum.

Rice transplanting as carried out in Egypt

8. *El Esbani.* Spanish variety. Good industrial yield, but poor production.

9. *El Anbari and El Rechti.* Grown by some fellahin for personal consumption because of their amber flavour.

To summarise, the seifi or summer crops come from the Japanese varieties grown on good soil, El Nabatat on the slightly saline soils, and El Fino on the soils with greater salinity. The Nili or flood crop in the Fayoum comes from El Sabaïni white, El Debi, and those Japanese varieties which are transplanted before July 15.

Although rice has gradually become a cash crop, it is still grown on the saline soils in the north of the Delta for its beneficial effect on the soil. On uncultivated soil containing soluble salts rice is grown immediately after Deineba (*Panicum crus galli*). Where there are more or less sterile zones in the midst of fertile land there is often black alkali enclosing carbonate of soda, and in these cases liming is necessary before planting rice. Doses vary between 1 and 15 tons per feddan.

Effects of irrigation

The frequent irrigations demanded by the rice crop allow the soluble salts in the soil to be dissolved and removed by drainage. Furthermore, the fact that the growing season occupies the summer and up to the beginning of the autumn avoids the possibility of the salts finding their way back by capillary action.

Where rice is grown to counteract salinity the seed is broadcast by hand. The subsequent method of cultivation is the same as for a cash crop. Yield is generally poor, varying with the salinity of the soil. When the soil is sufficiently improved for a biennial rotation, the following order is followed: rice—clover; cotton—clover. With further improvement in soil conditions rice is grown every third year with the following rotation: rice—clover—fallow—cotton—clover, or rice—clover—maize—cotton—clover.

Rotations

Where rice is a cash crop, it is grown as a summer crop, or occasionally as a Nile flood crop. It generally follows the winter crops of wheat, barley, clover, beans and flax and sometimes follows a fallow period after a cotton crop. In the north of the Delta two types of rotation are used. In the first, half the land is sown in November with wheat, barley and clover for harvesting in May; these are followed by rice and maize and are harvested in October-November. The other half of the land is worked during the winter ready for the cotton crop in summer. In the second rotation, one-third of the land is put to wheat and barley and one-third to clover, both followed by rice or maize, and the remaining third is put to cotton. Where rice succeeds clover or beans the yield is higher than where it succeeds cereals, unless extra fertiliser is used in the latter case. The second or third cutting of a clover crop is often left on the ground as green manure. When rice follows wheat the time between wheat harvest and rice growing is very short, and the fellah is apt to scamp the sowing. For this reason it is preferable to plant out young plants. Preparation of the ground is done by an Egyptian plough, which turns up the soil to a depth of about 12 cm., though on large estates more modern machinery may be used. Then begins the important work of levelling, so that the irrigation water may spread evenly over the land.

The first stage of this is done before irrigation with the help of a roller drawn by a tractor or by cattle. The whole area is divided into squares containing $\frac{1}{2}$ to $\frac{3}{4}$ of a feddan and these are surrounded by shallow ditches to retain the water. The ground is then inundated to a depth of 5 to 10 cm., and the second stage of levelling is carried out by harnessing transversally to two cows or buffaloes an iron beam 2 to 3 metres in length, which is then dragged over the muddy ground. This work is tiring to both man and beast and requires experienced handling if it is to be effective. The corners of the cultivated area have to be levelled by hoe.

Research

The Egyptian Ministry of Agriculture and the Royal Society of Agriculture have both carried out research to find the varieties of rice best suited to the country's

The rice harvest. Hand labour is evidently not in short supply

soil and climate. Whether the seeds used are from these selected strains or taken from plants grown the previous year, they are first passed through a winnower or separator. For rice grown during the flood season the seed is generally allowed to germinate before planting. To produce germination sacks are filled up to two-thirds with rice seeds leaving the remaining third empty to allow the grains to swell. The sacks are then immersed in an irrigation canal. Each day they are lifted out, accumulations of mud are removed, and they are left to drain for two hours before being again immersed. This goes on for from three to eight days, according to the temperature. Then the seeds are washed and sorted, spread out in a shady place and covered to a depth of 25 cm. with clover or damp straw. They are carefully watched to judge the degree of germination and avoid over-heating. Sowing can take place any time between 12 and 48 hours after the seeds have been covered, according to the temperature.

Sowing methods

Three methods of sowing are in use in Egypt: sowing broadcast, sowing in rows with the help of machines, and sowing in nurseries followed by transplanting. The first method is the oldest and most widespread. Before the seed is sown broadcast the land is covered with water to a depth of 5 cm. and the water is kept in a state of agitation during the sowing with the help of a thin board. The mud attaching to the seeds causes them to sink into the soil. This work is best done in windless weather by workmen who are specially skilled in spreading the seed evenly. A number of factors affect the amount of seed used, which may vary from 3 to 6 kelas* per feddan. After sowing the ground is left submerged under 3 to 5 cm. of water for from seven to ten days. The water is then drained away. After three or four days under the sun the ground is again irrigated, the depth of water varying with the height of the plants.

Sowing in rows with the help of machines is a method very little used in Egypt, mainly because the machines are too expensive for the small cultivator, but also because the imported machinery is often found to be too heavy for the very clayey Egyptian soil and for the draught animals used. Machines made locally of wood can be bought, but even these are not widely used.

Sowing in nurseries

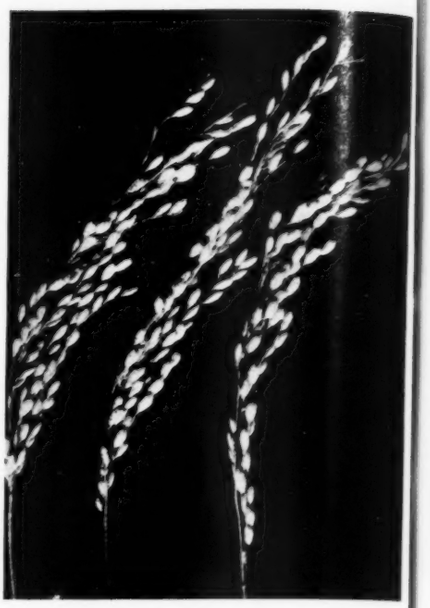
The method of sowing in nurseries and then transplanting has been developed in Egypt since 1935. There is very little difference in yield between seeds sown broadcast early in the season and those transplanted. But the latter method has definite advantages. As already mentioned, when rice is sown after wheat there may be very little time in which to prepare the soil and plant seed, and transplanting in such circumstances gives a better crop. When rice follows clover it is possible, if the rice plants have been transplanted, to gather a supplementary harvest from the clover. The fact that for a whole month only the small area where the nursery plants are growing need be watered leads to a saving of irrigation water at a time when this is scarce. There are, too, other advantages in the smaller amount of seed used, more even planting and less labour needed for levelling the ground. In the nursery itself the seeds are broadcast by hand and transplanted between 30 and 40 days after sowing, generally between May 15 and July 1. Machinery is rarely used for transplanting and where it is used it is of local manufacture. Where seed has been sown broadcast in the field some of the plants may have to be thinned out and extra plants put in other parts. This work is unnecessary where transplanting has been used and the subsequent weeding is also less arduous.

Harvesting

The rice harvest is gathered from the beginning of September to the middle of November, according to the date of sowing. It is important to choose exactly the right moment for harvesting. If the plants are too mature there will be losses by shattering, particularly with the Japanese varieties; if, on the other hand, the rice grains are not sufficiently ripened there is a risk that they will not keep well. The best time to gather the crop is about four days before the plant reaches its full growth. The ground is drained and the crop cut with a sickle. The plants are gathered into sheaves and left on the field for four or five days.

The small farmer generally threshes his rice on a threshing floor with the help of what is called a Carthaginian wagon fitted with iron discs and drawn by draught animals. On large estates two or three of these wagons may be drawn at the same time by one tractor. Some of the small farmers winnow their crop, but this does not clean the grains sufficiently of impurities. A few of the large landowners are now using threshing machines specially designed to deal with rice.

To stand storage Egyptian paddy should have a moisture content of 13-14%.



Yabani Pearl, one of the Japanese varieties which has been developed in Egypt

Fertilisers

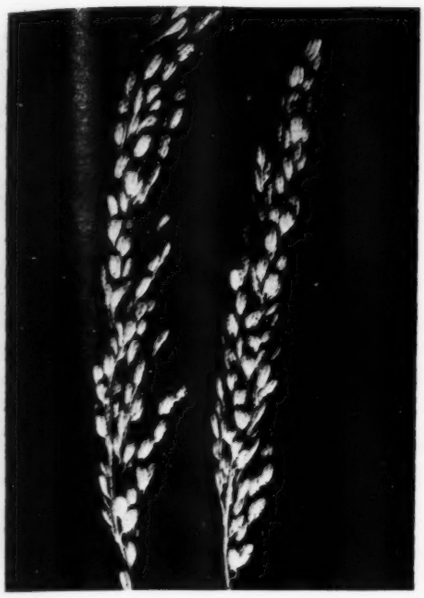
For nitrogenous fertiliser the Egyptian farmer uses sulphate of ammonia, farm manure and cotton cake. The first of these is the most widely used. Farm manure has always been used on the saline soils of the Delta, where the cultivation of rice has developed, but elsewhere this manure is kept for the maize and wheat crops.

Sulphate of ammonia is applied at the rate of 75 to 150 kg. per feddan. The first application is made 30 to 40 days after sowing, and the second 20 days later after weeding. The nursery for young plants also receives two applications of 100 to 150 kg. per feddan.

The use of cotton cake as a fertiliser was encouraged by the Egyptian Ministry of Agriculture in 1946 when supplies of sulphate of ammonia were inadequate. The cake from husked cotton seed, which has the highest nitrogen content, is made by only one factory in Egypt. Taking all factors into consideration, it would seem wiser to use cotton cake as an animal foodstuff rather than as fertiliser, particularly as sufficient supplies of the cheaper sulphate of ammonia are now assured, the greater part being imported from Belgium.

A second fertiliser used is superphosphate. The dose varies between 100 and 200 kg. per feddan. It was estimated in 1949 that the Egyptian rice crop needs about 75,000 tons of both nitrogenous and phosphatic fertiliser each year. The writers of a booklet state that by 1955 production of superphosphates in Egypt was expected to be 100,000 tons per annum.

* A kela ($^1/_{12}$th part of an ardeb) = .45 of a bushel.



Nabatat Asmar, developed from a Persian strain

Rice milling

The rice industry in Egypt, which was founded in 1825, began to develop on modern lines about 1920. The most important mills are in Alexandria, Mansoura, Mehalla el Kobra and Damietta. The operations carried out include drying, cleaning, husking, polishing and dressing. There are still many smaller mills using less up-to-date methods. With the increase in rice acreage these mills have played an important part in production and it is to be hoped that they will gradually modernise their equipment.

Rice for export is oiled with mineral oil, or glazed with talc and syrup of glucose. For local consumption rice is sprinkled and mixed with plaster and sodium chloride. It is difficult to give exact figures for the production of rice and its various by-products, as so much depends on the methods used in the mills. Well-equipped mills naturally have a smaller percentage of broken grains. As a guide, however, the following figures have been compiled for the 'El Yabani' variety to show the average of the different products:

Consumption and exports

Consumption of rice per head of population in Egypt was 11.4 kg. in 1920-24. This figure rose steadily in subsequent years and by 1948 had reached 25 kg. Rice is particularly popular as a foodstuff in Lower Egypt, where the fellah keeps some of his harvest for his own consumption. Rice is generally eaten in its natural state, but during the war much use was made of rice flour to mix with wheat flour in making bread.

Exports of rice from Egypt have increased steadily since 1920, as the following figures show.

Rice is in fact the second most important Egyptian export after cotton.

Formerly the greater part of the exports went as cargo and some as paddy rice, but with the gradual modernisation of the Egyptian rice industry rice exported since 1935 has gone mainly as bleached or glazed white rice. Before the war the chief importing countries were Rumania, Greece, Bulgaria, other Middle East Arab countries, Belgium, France, Great Britain, Switzerland and Scandinavia. During the war the export of rice was governed by special agreements between the Egyptian and the British governments under which Egypt received in return imports of wheat. Since the war exports have been under the direction of the International Food and Agriculture Organisation.

By-products

The starch industry, which came into being in Egypt during the war, takes part of the rice crop, particularly broken grains.

The most important by-product of the rice industry is rice bran, which forms about 10% of the paddy rice dealt with by the mills. This is used, though not very widely, as food for cattle. An industry for turning the bran into concentrated cattle food has been in existence in Egypt for some four or five years. Exports of bran are sent to Switzerland, Italy and Denmark.

The rice husks are used as fuel in the mills. The resultant ash, which is composed almost entirely of silica, is treated with soda or carbonate of soda by the Egyptian chemical industry to obtain silicate of soda. The husks are also used as stable litter for farm animals.

Rice straw is used in Egypt to make a paste for the manufacture of excellent quality paper. By this means the Egyptian paper industry has been able to expand its production considerably.

(From *The Journal of the Anglo-Egyptian Chamber of Commerce.*)

EXPORTS OF COTTON AND RICE FROM EGYPT

Year	Total Exports	Exports of Cotton	Exports of Rice
	£E	£E	£E
Average for 1920-24	58,932,161	49,851,397	351,270
" " 1925-29	51,443,161	42,305,750	521,326
" " 1930-34	29,002,456	20,935,578	569,048
" " 1935-39	34,370,805	25,194,462	1,026,824
" " 1940-44	24,132,605	17,349,724	1,311,086
1945	41,629,998	35,172,717	4,056,469
1946	63,680,534	46,218,218	5,933,484
1947	86,980,023	67,223,000	6,113,113
1948	138,298,380	113,326,660	16,063,630

Royal Agricultural Society

The 113th volume* of the Journal of the Royal Agricultural Society of England well maintains the high standard set by its predecessors and contains a large number of articles.

The special articles include a collection of four contributions under the general title of 'Some Aspects of Lancashire Agriculture,' which deal with agricultural conditions under such diverse circumstances as the intensive farming of the Ormskirk district, marginal holdings of East Lancashire and glasshouse horticulture of the Blackpool area.

Other general articles include 'Marginal Land Reclamation,' by Dr. D. A. Boyd and Dr. W. Ellison (the latter's recent book on the same subject is reviewed in this issue); an article from Rothamsted dealing with recent experiments carried out at that centre with field beans; and a series of two articles on 'International Co-operation in Disease Control,' one of which, by Mr. K. L. Kesteven, deals with the Rinderpest problem and especially with recent developments in Africa and the Far East; the second is by Mr. O. B. Lean, reviewing developments in locust control.

As usual a substantial part of the volume is taken up with a section which has become widely known and appreciated under the title of 'The Farmer's Guide to Agricultural Research.' This comprises upon the present occasion articles by Dr. C. S. Orwin on Farm Economics, Dr. E. W. Howard on Plant Breeding, Dr. Walter Russell on Soils and Fertilisers, Mr. S. J. Wright on Farm Machinery, Dr. J. Duckworth on the Feeding of Livestock, Dr. S. Bartlett on Dairy Farming and Sir Thomas Dalling on Disease of Animals. All of these authors being acknowledged authorities in their own line, the articles, as may be imagined, are authoritative reviews of the main advances achieved during the year.

* *The Journal of the Royal Agricultural Society of England*, Vol. 113, (inc. Royal Show supplement). Pp. lii + 251, illustrated. John Murray, London, 1953. 20s. (non-members).

The Bangweulu Swamps

Professor FRANK DEBENHAM, M.C., O.B.E., M.A., D.Sc.

An expedition led by Professor Frank Debenham recently conducted a survey of pastoral possibilities of the vast Bangweulu swamps of Northern Rhodesia. In this article, the author outlines some of the development problems and possibilities of the region.

THE world is approaching saturation point for the human species—in some places it has already passed that point. Every day there are a million or so more mouths to be filled. What wonder, then, that large organisations such as the FAO and the Colonial Development Corporation are looking for more productive land to produce more food for the world and stave off the day of starvation.

Now it is a trite observation, but a true one, to say that crops are the product of soil, sunshine and water, and in much of the land surface one or other of these is deficient.

Experts have therefore turned to localities where all three are present in embarrassing excess—the swamps of Africa—and have been puzzling over means of producing food from them.

In their natural state, these swamps are growing millions of acres of reeds and papyrus and it should not be beyond the ingenuity of science to turn that useless vegetation into something edible by man, either directly, as crops, or indirectly, as animals reared on the vegetation.

In the steps of Livingstone

That was the general aim of an expedition, in 1949, to the great Bangweulu Swamps of Northern Rhodesia, up to 5,000 square miles in area, best known as the scene of David Livingstone's last journey and lonely death in 1873.

For the last 40 years, individual district officers have journeyed through the swamps, made improvements to the waterways, and encouraged the large native industry of fishing. In the midst of their many other duties they could do little towards making a map of the swamps and less still towards studying the habits of the water, that is to say, the regime of the swamps, both of which tasks are pre-requisite to any full study of what might be done towards development. As a result of the expedition we now have a passable map and some understanding of why the water goes where it does; but the work of four men in three months over such a vast area cannot be regarded as more than a preliminary reconnaissance, pointing the way to further and more specialised investigations.

In broad outline, the swamps are a triangular area of seasonally flooded land, 80 miles to each side of the triangle with a lake, 50 miles long, in the north-west corner. This is fed at the upper end by a large, well-defined river, the Chambeshi, which distributes the water over the flattish area and then issues at the lower end as another river, the Luapula, which is really the infant Congo.

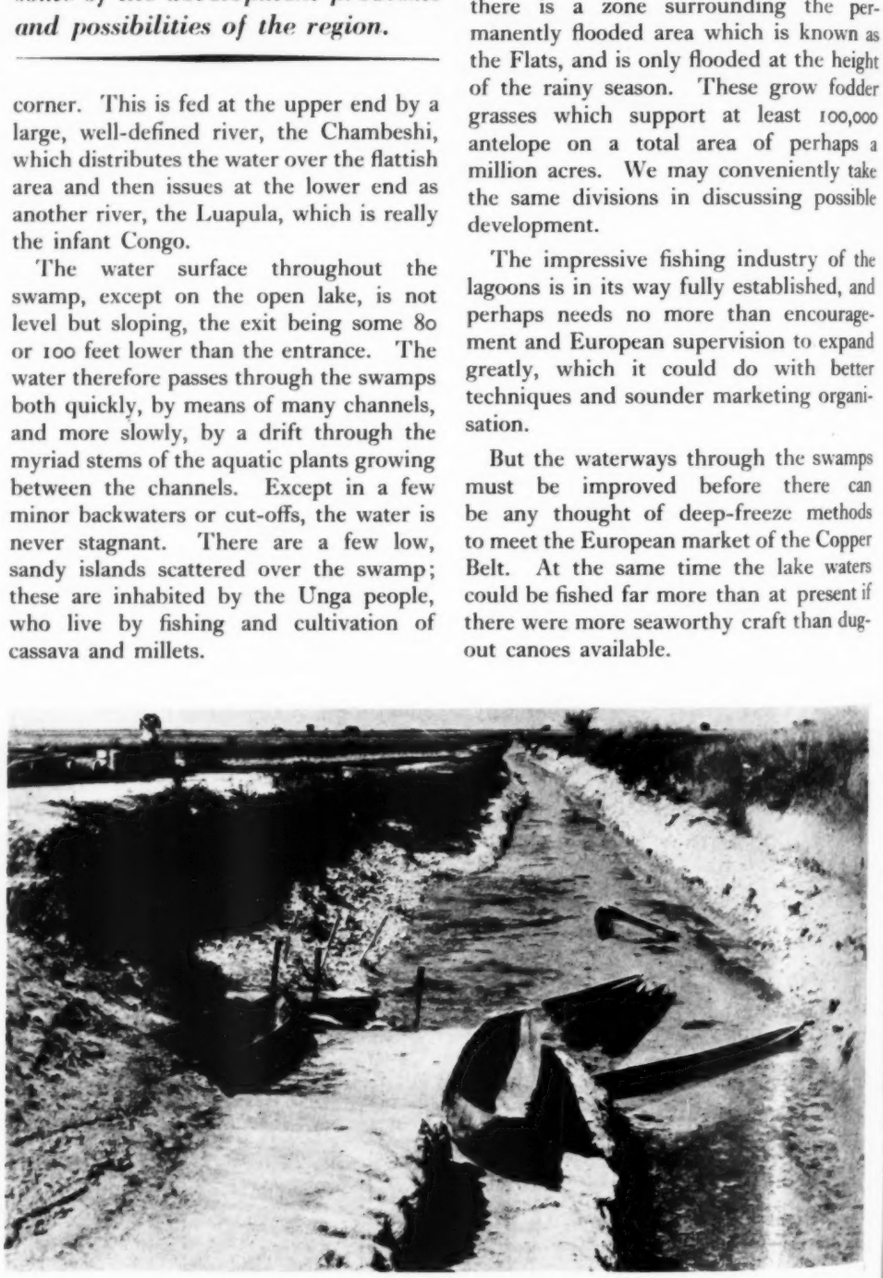
The water surface throughout the swamp, except on the open lake, is not level but sloping, the exit being some 80 or 100 feet lower than the entrance. The water therefore passes through the swamps both quickly, by means of many channels, and more slowly, by a drift through the myriad stems of the aquatic plants growing between the channels. Except in a few minor backwaters or cut-offs, the water is never stagnant. There are a few low, sandy islands scattered over the swamp; these are inhabited by the Unga people, who live by fishing and cultivation of cassava and millets.

100,000 antelope

The whole area of the swamp can be divided into three zones, caused entirely by annual flooding. There is the lake and several large lagoons, which have a range of some 3 or 4 ft. in level during the year. Then there is the true swamp, from 2 to 12 ft. deep, supporting the reeds which vary in luxuriance and density. Finally, there is a zone surrounding the permanently flooded area which is known as the Flats, and is only flooded at the height of the rainy season. These grow fodder grasses which support at least 100,000 antelope on a total area of perhaps a million acres. We may conveniently take the same divisions in discussing possible development.

The impressive fishing industry of the lagoons is in its way fully established, and perhaps needs no more than encouragement and European supervision to expand greatly, which it could do with better techniques and sounder marketing organisation.

But the waterways through the swamps must be improved before there can be any thought of deep-freeze methods to meet the European market of the Copper Belt. At the same time the lake waters could be fished far more than at present if there were more seaworthy craft than dugout canoes available.



A section of the Bangweulu swamps in the dry season. Note the African dugout canoes

Rice crop prospects

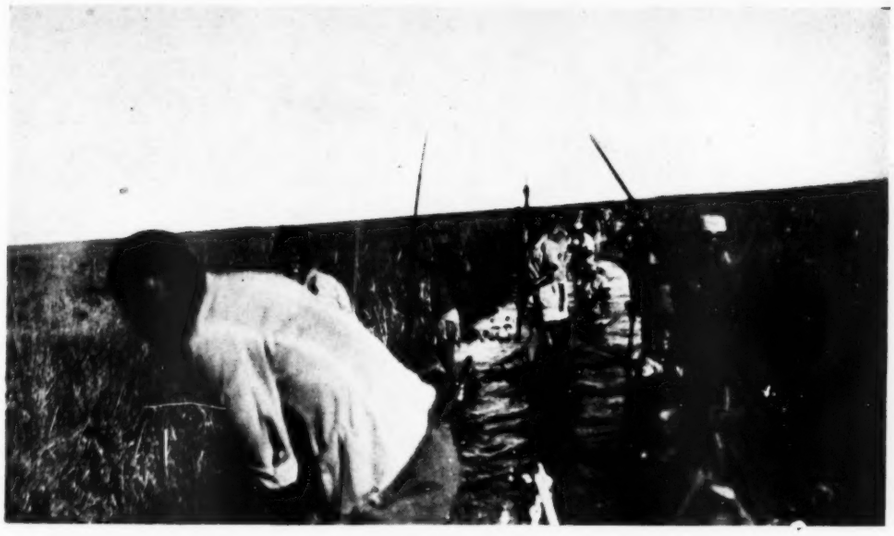
The true and permanent swamp, crowded with aquatic plants, is probably best left in its present state, as it is the refuge and to some extent the food of the fish, but if the waterways are improved the flooding would probably be less extensive and much of the land now drowned would be available for cropping. Naturally, one thinks of rice as an ideal crop for a tropical swamp, especially as there is a form of wild rice already there. Growing rice is not quite so simple as that, however, because the rains come at rather an awkward time and heavy flooding is due just at the normal time of ripening for rice. At least there can be no question yet of two crops of rice per year, as is possible at sea-level in the tropics.

In spite of this, some rice is already grown there on small plots, and this will increase if the price suits the growers. But the Africans' methods are at present crude, under what has been called their bondage to the hoe, and output will never be high until they are converted to some degree of plough culture. Rice under mechanical cultivation may well be considered over the very large areas annually flooded, but cautious pilot-schemes would be necessary.

Cattle chances

The grassy Flats with their large population of game are an invitation to the rancher, but again there is a major obstacle —this time in the shape of the tsetse-fly which surrounds the whole area. The fly will not leave the shade and shelter of the trees for more than a few hundred yards, however, so that cattle out on the Flats would be safe. It remains to be discovered by careful investigation whether, in time of flood, there is enough room for the stock to be kept above the flooding on the one side and far enough from the tree-line on the other.

A minor hindrance is that the local people are not acquainted with domestic animals, in fact are afraid of them, so that cattle-men from other tribes would have to be brought into the area to begin with. There is an analogy with the great cattle areas of the Sudd region of the Upper Nile, where the Dinka, the Shilluk and the Nuer tribes are wholly dependent on the annual flooding for their vast herds of cattle. There, however, the fine soil is almost impervious to water, so that these nomads have to follow closely the water-level as it rises or falls on the flats. On the Bangweulu Flats the soil has a good proportion of sand in it and water penetrates it, so that grass will continue to grow after the flood has subsided. If the grass is burnt off at almost any time of the year fresh growth springs up.



Natives digging a channel through the swamps

We know far too little about the Flats yet to be certain, but there is no doubt that they invite close investigation as a source of beef, for which there is a sure market in the Copper Belt nearby.

The Unga people

The people in the true swamps belong to the Unga tribe, who are accomplished fishermen, sturdy and independent, but not well aware of their opportunities. Round the outskirts of the swamps the population is more intelligent, perhaps—growing grain and selling it to the Unga people for dried fish. Many of them go to the copper mines for work, and some appreciation of the white man's use of machinery is therefore seeping into the villages, the first effect of which is a desire for sewing-machines and bicycles.

It is surprising how peaceable all these people are, considering that only a few-score years ago they were always raiding each other for vengeance or for slaves. They have long since accepted the authority and welcomed the justice of their British administrators. When they see a large canoe flying the Union Jack coming to their swamp islands they receive the District Commissioner with that characteristic mixture of awe, admiration, and trust which British rule in Central Africa has inspired in the past.

Strange beauty

The administrators themselves become very devoted to their swamps, which, contrary to expectation, are not monotonous nor even unhealthy, by African standards.

Gliding down the maze of channels in a large native dug-out is a delightful experience, the paddlers all standing and keeping up their 40 strokes a minute for hours on end with every now and then a burst of song in their quaint harmonised tunes. The bright green of the papyrus stems makes a background to the countless water-lilies and other low plants, while in their season there are a myriad coloured blossoms of climbing plants. Bird-life is prominent, and if one's luck is in there is an occasional glimpse of the swamp antelope, splay-footed so that he can pass where man cannot.

No wonder, therefore, if the district officers enjoy their periodic tours of the swamps and are indeed jealous of development coming too quickly.

(From *Colonial Development.*)

New Zealand Leads World in Farm Output Per Man Hour

New Zealand leads the world in farm production per man hour, according to the International Federation of Agricultural Producers.

A report from New Zealand says that country also leads the world in annual rate of increase in agricultural production.

Australia is second in farm productivity per man hour and United States is third. The report on the statistics comes from Mr. Colin Clarke, an Australian economist, who will shortly become Director of the Institute of Research in Agriculture Economics at Oxford University.

Mr. Clarke says the biggest increase in agricultural production which any country could hope for would be from two to three per cent. per year.

South African Crop Prospects

OUR South African correspondent has sent us the following information regarding the outlook for certain crops in the Union of South Africa.

Lupins as a vegetable

A new type of vegetable—the sweet, white lupin—is being cultivated by the Stellenbosch-Elsenburg College of Agriculture, and Mr. S. A. Hulme, an agronomist at the College, firmly believes that it will one day be served on dinner tables. Lupins are well known for their value in enriching soil by nitrogen fixing, and as an animal fodder, but what is less widely known is that during the war this variety—*Lupinus albus*—was used in Germany as a food. It is rich in protein, and the seeds, which grow in pods very like peas, have a sweet flavour as good, if not better, than the ordinary green pea. Mr. Hulme said that the sweet white lupin was not yet being used commercially in South Africa. It was being tested at the College and showed great promise. If it passed all the tests it would be used commercially, and would play a big role as animal food and also perhaps as human food. In a time of meat scarcity it would also provide a valuable source of proteins for human beings, as it was a most tasty vegetable.

Deciduous fruit

The prospects for a bumper 1952-53 deciduous fruit crop were particularly rosy, said the chairman of the Deciduous Fruit Board in a recent speech. In spite of heavy losses of grape, plum and peach crops in the most important fruit-producing areas, owing to unfavourable weather, last season's total revenue from deciduous fruits exceeded that of the previous year. The reason for the rise in income from deciduous fruits last season was the higher prices obtained for apricots and apples. Although about 2 million trays of grapes were exported, and sales on the local market also increased considerably, the net price of 3d. a lb. for the season to the producer was maintained. Marketing was still the greatest problem. The DFB is negotiating with the United States in an effort to increase the market for South African fruit there. The prospects, however, are not encouraging because the delivered price of South African grapes and other deciduous fruits is too high for the American consumer. Efforts are also being made to increase the turnover on the Scandinavian, German, Holland and Far Eastern markets.

Cotton

Cotton continues to be an extremely profitable crop to Africans in Southern Rhodesia. Last year there were 11,000 registered native growers, who produced nearly half as much cotton again as European growers. In the Lower Gwelo reserve, more than 11,748 lb. of native-grown cotton were sold in October, one native obtaining more than £46 for his cotton crop.

Oranges

The domestic price of oranges in the Union is the lowest in the world, and the quantity of oranges marketed in the Union has doubled since the Citrus Control Board was formed, states the Board in a survey of its activities. The survey states that before the Board came into being in 1940 it was not unusual for growers in the Transvaal to rail fruit to Port Elizabeth, while the same kind of fruit was being railed from the Cape Eastern Province to Johannesburg. Smaller centres received poor supplies. The Board changed the marketing system overnight, and improved the grading and packing standards on the home market. In agreement with the growers, the Board decided that part of the export quality fruit should be retained for sale in the Union and so raised the quantity of fruit for the home market from 3,500,000 pockets in the years just before the war to more than 6,080,000 pockets last year. The Citrus Control Board now supplied 275 markets in the Union and was in constant touch with these markets.

The considerable contraction in the export figures during the current season is a measure both of the decline in production caused by drought in the past year and also of the damage sustained by the current crop as a result of recent storms.

Export policy for fruit

According to the chairman of the Council for the Development of Natural Resources, the Deciduous Fruit Exchange had followed an 'unhealthy and short-sighted policy in sending fruit only to markets where very high prices were obtained. In this way not only the African market but also to a large extent the American and Canadian markets were neglected.'

He urged that greater attention be paid to the development of markets in Africa, which would be less hit in times of war. The chairman of the Deciduous Fruit Board said that large amounts would be spent on advertising in Britain—£50,000 to advertise grapes and £10,000 for other fruit. Big crops were expected in the Tranvaal and the Cape, and the market would have to absorb increasing quantities. As higher prices might affect the demand the Board had decided not to increase them. New markets were being developed and growers had to share the risk taken in their development, sharing profits and losses that might result. Crop and market prospects were good this season. The problem of finding markets for the Union's deciduous fruit was becoming 'increasingly important' and 'urgent' in the case of grapes.

Alphonse Lavalle grapes in the Paarl Valley. These grapes are mainly exported

Grapefruit growing in the south-eastern State of Florida

Investigations in Citrus Production

With Special Reference to the Nutrition of the Crop

F. C. DARCEL

Great importance is attached to the mineral nutrition of citrus. In recent years Florida has become one of the main citrus producing areas of the United States. Most of the soils used are very infertile sands; indeed citrus could not be grown at all without the use of mineral fertilisers. Again, much of the work on trace element deficiencies has been done on the citrus soils of Florida. Some of the more important citrus soils in the United States are first briefly described, followed by a discussion of recent findings on the moisture requirements of the crop, and on diseases which are affected by soil conditions. An account is given of recent research in various parts of the world on the various roles played by the major plant nutrients and the minor and trace elements.

THE chemical characteristics of the Florida soils have been discussed in detail in one of the Agricultural Experiment Station Bulletins (33) ; some information on the common types of soil profiles is given below.

Citrus is largely grown on the well-drained upland soils, *e.g.*, the ' high pinelands ' of Central Florida. These soils have good natural drainage but very low natural fertility and a very low colloid content, most of which is provided by soil organic matter.

One of the best soils is the Norfolk Fine Sand, hammock phase. Similar textural features with fine sand above sandy-clay at variable depth characterise most of highly-rated upland soils of Florida. However, heaviest yields are obtained on rich alluvial soils.

The less satisfactory soils are imperfectly drained and are known variously as ' low hammocks ' and ' palmetto flatwoods.'

Most profiles consist of grey to black topsoil changing through pale coloured sand or mottled sandy-clay to marl, usually within three ft. from the surface.

In California, medium-textured soils gave the highest yields, with the lowest on the lighter-textured soils[20]. Indeed, it seems that citrus can be grown on any type of soil if managed correctly. However, gentle valley slopes are most suitable and areas of poor drainage and low topography should be avoided, particularly where there is a danger of frost[20].

Under good management, considerable attention is paid to soil acidity. The reaction should be maintained within the range pH 5.5-6.0 to keep the soil manganese, zinc and iron in available forms[5, 6, 33] and also to prevent magnesium deficiency symptoms, which commonly occur on the more alkaline soils through an excess of free lime.

A suitable range of soil reaction is also beneficial by helping to maintain the nutrient status of the soil through the control of leaching. In one series of experiments repeated soil analyses indicated the conserving effect of maintaining a higher pH (5.7) on extractable calcium, magnesium, phosphorus and manganese.

It is of interest to note the recent findings on the ' citrus-sick ' soils of Florida. The trouble is now attributed to an organic toxic material, produced by *Fusarium solani* and *Pyrenochaeta* spp., which gradually accumulates in citrus soils[25]. Germination is seriously reduced and the seedlings suffer from root-tip damage.

Soil moisture

An adequate water supply is essential for maximum fruit production. In areas of deficient rainfall soil moisture can be conserved by planting the orchard on the contour with graded drainage banks[27] and by the use of mulch.

Premature defoliation is caused by severe moisture deficiency and is usually accompanied by leaf scorch through the toxic concentrations of salts. The condition is less likely on the deeper soils and in species which carry fruit all the year round[37]. Corrective measures include increased frequency of irrigation, and the prevention of excessive leaching, salt accumulation or recurrent high water table under the trees by the use of improved irrigation furrows and soil drainage[37].

Irrigation is now widely practised, particularly under the dry climatic conditions of California. Care must be taken in its use, however.

Detailed studies of root distribution in citrus have shown that furrow irrigation is frequently wasteful and ineffective. Overhead irrigation which moistens the soil below the crown is markedly preferable, particularly in conjunction with cover cropping, mulching and the limitation of cultivation to the minimum[36].

The incidence of some root diseases becomes serious when the soil is over-irrigated. As an example, workers in the Transvaal have shown that the avoidance of soils in which moisture content is likely to become excessive by irrigation, and maintenance of a high nitrogen level, are effective in preventing and controlling dry root rot and diplodia gummosis (*Diplodia natalensis*)[24]. The method of application of water is also important. In controlling brown rot gummosis (*Phytophthora citrophthora*), which is favoured by moist and cool conditions in Natal and the eastern Cape Province, irrigation water should be kept two ft. away from contact with the barks by parallel ridges on either side of the trees[24].

Mineral fertilisers

A number of fertiliser trials with citrus have recently been recorded. Leaf analysis, as a means of determining the nutritive condition of the plant at various stages of growth, is being increasingly used. Considerable fluctuations in the mineral content of the leaves have been noted. Nitrogen, phosphorus and potassium contents declined with age, calcium increased rapidly for four to five months and then remained constant and magnesium reached a peak in five to six months, dropping to a low level in old leaves[23].

A correct balance between the different fertilisers is essential. Indeed, a high content in the soil of any one base (*e.g.* calcium, magnesium) will inhibit the absorption and/or utilisation within the plant of bases present in lesser amounts[14].

The mineral status of the leaves can vary widely with the types and quantities of fertiliser used. The results of one experiment on these lines are given below.

On experimental plots, mainly of sandy loam, Eureka lemons showing symptoms of leaf spot on the older leaves were treated with 2.3 lb. of nitrogen per tree, alone or in combination with 9.6 lb. of phosphorus and/or 10 lb. of potassium. Significant response to phosphorus resulted in an increased phosphorus content from 0.08% to above 0.1% in recently matured leaves. Treatment with potassium depressed yields, apparently by reducing the phosphorus and magnesium levels of the trees. The potassium content of young leaves in most cases was above 0.4%, regardless of treatments, and the results indicated that spotted leaves were associated primarily with phosphorus deficiency, and that the composition of recently matured rather than spotted old leaves should be taken as an indication of the nutrient status of the crop[1].

In another experiment elimination of PK treatments caused a marked decrease in the phosphorus content throughout the tree and an increase in potassium and nitrogen in the leaves[41].

Some interesting work has recently been done on the utilisation and retention of fertilisers, using lysimeters. The utilisation of fertilisers was found to be small, amounting to 20% for potassium, 10% for nitrogen and 7% for phosphorus. Lysimeter studies showed losses by leaching of 8.56% of potassium, 1.73% of nitrogen and 0.6% of phosphorus of the amounts applied[7].

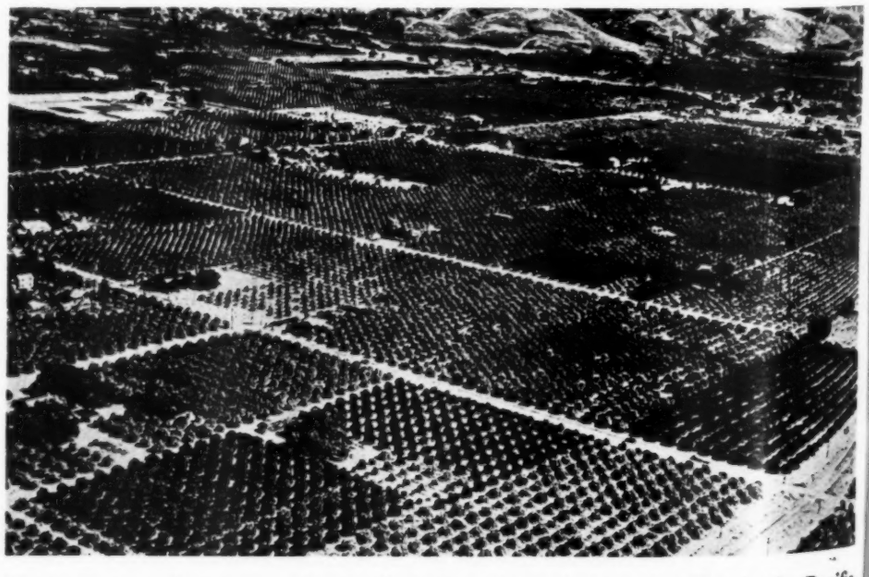
Nitrogen

Leaves of the orange suffering from nitrogen deficiency become pale to yellowish green, and may eventually become completely yellow and finally shed. The fruit is small, pale in colour and ripens prematurely[3].

The results of a number of fertiliser trials show that nitrogen is usually deficient except on the more highly organic soils, such as the Davie soil of Florida with 14% or more of organic matter[2].

Fertiliser experiments conducted over a period of 22 years with Washington Navel oranges on a soil classified as Ramona Loam gave marked yield responses from three lb. per tree of nitrogen applied in autumn, half as mineral fertiliser and half as manure. Increased dressings of nitrogen did not show any additional benefit, and continuous use, particularly of sodium nitrate or ammonium sulphate, adversely influenced soil structure and fruit yields. Excess of nitrogen was also found to cause thickening and softening of the fruit skins, and reduction in the powers of resistance of shoots to various diseases[38]. The harmful effects of excess nitrogen can be minimised by gypsum, limestone, manure and cover cropping. Cover crops preceded by dressings of bulky organic materials were found to increase both fruit yields and size[3].

In trials with neglected orange trees grown on sandy soils in Palestine, responses were obtained with annual applications of one kg. of ammonium sulphate per tree occasionally supplemented with two kg. of superphosphate. Lopped trees appeared to have stored reserves of nitrogen. It was also found that 'unbalanced' trees, those either heavily pruned or unfertilised, produced larger fruits of poorer quality. Clean cultivation



Citrus groves of orange and grapefruit trees in an irrigated valley in the Pacific Coast State of California

Citrus and tung trees growing in pure sand and fed by nutrient solutions at the sub-tropical Horticultural Research Station, Nelspruit, Eastern Transvaal

of groves seemed to be equivalent to applying nitrogen fertiliser[28].

In other experiments, the total yields and internal quality of grapefruit and orange supplied entirely with inorganic nitrogen appeared slightly better than those receiving 40% of the nitrogen in organic form, provided adequate magnesium, copper, zinc, and manganese were also added. It was recommended that, as the organic fertilisers often supply trace elements, they may be preferable to inorganic fertilisers when minor elements are not included[35].

Large nitrogen losses occur as the result of leaching and volatilisation, a high content of phosphorus in the soil being thought to increase the loss by volatilisation. Possible means of reducing these losses are suggested, including frequent applications of small doses of nitrogen to irrigation water, the use of low head sprinkler irrigation, non-cultivation, and making neutral and alkaline soils slightly more acid[9].

The soil nitrate content shows wide variations from one sampling spot to the next and at different times of the year. In one investigation, nitrate levels in the top 30 cm. varied from 4 to 12 p.p.m. 20 or more soil samples were required for an estimation of soil nitrates in a grove area of two dunams (2,000 sq. m.). Leaf analysis required five to eight samples. Spring was found to be the most suitable season for soil sampling[19].

Phosphorus

Considerable work has also been done on the part played by phosphorus in the nutrition of the crop. Where phosphorus is deficient, the leaves of the orange are dark green with the older leaves faded green to bronze.

Oranges and lemons seem to require different quantities of phosphate. In one experiment, using different rates of application, a beneficial action of phosphorus occurred on lemon in the high range, but on orange only in the very low range of phosphorus concentration. With larger phosphorus concentrations it was relatively easy to maintain an adequate nitrogen supply for lemon, but not for orange cultures[57].

On the highly organic Davie soils, applications of phosphorus had a very decided effect on yield. Plots receiving no phosphorus gave the lowest production and the poorest quality fruit. On the other hand, high concentrations of phosphorus caused excessive fruit drop and other symptoms of copper deficiency[12].

Phosphorus applications in excess of calculated uptake were in no way harmful but improved the quality and reduced the maturation period of the fruit[38]. Applications of treble superphosphate slightly increased the calcium and magnesium content of the plant but decreased the potash[23].

The effects of phosphorus were investigated over a period of nine years on oranges, grown in out-of-door solution cultures at levels ranging from 2.5-3.5 to 150-175 p.p.m. of phosphorus. The results indicated that (*a*) low levels particularly affected the firmness of fruit and juice quality and made trees susceptible to 'water spot' during cold spells, and (*b*) high levels encouraged pathogenic fungi and tended to aggravate zinc, manganese and iron deficiencies[10]. Leaves from phosphorus deficient trees were high in nitrogen and potassium, but low in calcium.

The ideal phosphate status was tentatively given as 0.12-0.13% of total phosphorus in five to eight months old spring-cycle leaves.

Accumulation of mono-calcium hydrogen phosphate in sandy soils of Central Florida is due to continual use of superphosphate and the adjustment of soil pH to 5.5-6.0 with ground limestone. The accumulation increases the retention of added sulphates of magnesium and manganese but not potassium chloride or sulphate. It also results in improved growth and yield of grapefruit[40].

Potassium

Potassium is also of great importance, particularly in relation to the quality of the fruit. In grapefruit, deficiency is shown by the die-back of the topmost leaves ; the leaves are irregularly coloured, pale and bronzed ; fruit production is small. In orange, the leaves show 'fluting' or 'tucking' ; tiny germ spots enlarge, become roughened and dark coloured ; the fruit is thick skinned, coarse and of poor colour with the juice low in acids and high in solids[3].

In long-term experiments it was found that the size, but not the number, of fruits was increased by potassium sulphate. Fruit size was correlated with potassium concentration and dry weight of leaves. Organic fertilisers produced similar results. Fruit size was not related to phosphorus, calcium or nitrogen concentrations[29]. High quality fruit was produced by manuring with potassium carbonate and wood ashes[38].

The type of potash fertiliser does not seem to be important. Similar responses were obtained on fairly highly organic soil (Davie soils—Florida) with either the chloride, sulphate or carbonate[12].

The absorption of potassium by the plant is affected by the quantity of calcium. Potassium replaces calcium in the soil colloids more readily than it does the hydrogen of acid soils ; hence the efficiency of the soil colloids in absorbing potash from a fertiliser solution is increased in the more alkaline soils[33].

Foliar diagnosis is an important aid in determining the fertiliser requirement of the crop. The ratio, in equivalents, of calcium plus magnesium to potassium per unit of dry weight, was much modified by fertilising practices and increased steadily with age.

Soil tests for potash may be somewhat misleading owing to the deep rooting habit of the plant in good structured soils,

as in an investigation reported from Brazil[38].

Excess potash manuring should be avoided. An unpleasant salty taste persisted in fruit of orange trees three to five years after applying potassium chloride in an unbalanced fertiliser mixture. It was concluded that on this particular soil, phosphorus was the limiting factor[38].

Although potash influences fruit quality, it is worth while mentioning the effect of the time of picking. Under normal conditions the quality of the fruit at the time of harvest is of prime importance. The quality of the fruit is affected both by the stage of ripeness at which it is picked and by the mineral nutrition of the parent crop. As a general principle, the crop should not be harvested until the fruit is mature.

Trace elements

It has already been noted that citrus is widely grown on sandy soils of low fertility. Both the major and minor plant nutrients are usually lacking.

Magnesium, manganese, zinc and copper have received the greatest attention over recent periods. Boron is also an essential nutrient.

Mineral elements

By making a study of the chemical composition of fruit and foliage, Fudge has shown that 'bronzing' of citrus is definitely associated with **magnesium** deficiency[13].

The deficiency symptoms often occur on calcareous soils as in Florida with an adverse calcium to magnesium ratio. For full utilisation of the magnesium, this ratio should be 8-10 : 1[33]. The use of magnesium sprays is now almost general practice in some parts of Florida.

The usual symptoms of manganese deficiency on the orange have been described as: 'Young leaves show a network of green veins on a lighter green background; in severe cases entire leaf assumes dull yellowish green followed by shedding; fruit poor colour[3].' The deficiency trouble is widespread in Florida, occurring on both acid and alkaline soils throughout the growing areas[5].

The 'frenching' of Florida or 'mottle-leaf' of California is caused by **zinc** deficiency[3]. The leaves are chlorotic with irregular green bands along the midribs and lateral veins; the twigs tend to die back and the fruit quality and quantity may be affected according to the severity of the disease[3]. Zinc sprays are satisfactory as a control measure. Soil applications are usually unsatisfactory partly due to the poor root systems of affected trees[8] but also though fixation in the soil.

In Florida 'frenching' of citrus occurs most commonly on acid sandy soils below pH 5.0, very low in exchange capacity, as well as on calcareous or over-limed soils. It appears that in acid sandy soils most of the zinc reserves are depleted by leaching, but are fixed in unavailable forms in the more alkaline soils[6].

Copper and zinc deficiencies often occur together. The symptoms are described thus:—'Terminal growth dies back, leaves commonly irregular in contour, usually with a bowing up of midrib; in acute cases heavy twigs put out a profusion of young soft shoots with small leaves which die back from tips with reddish excresences; fruits may be bumpy and covered with reddish brown excresences; juice low in acid and pulp[3].

Iron deficiency also occurs occasionally. 'Terminal leaves chlorotic between veins at first; leaves thin; in severe cases entire leaf becomes yellowish to orange, may show necrosis, at which time leaves shed beginning at terminals; fruit sparse, small, hard, coarse and light in colour.'

Boron deficiency is occasionally reported. 'Young leaves develop small water-soaked areas which become spots on older leaves; shedding takes place from top leaves downward; fruit brownish in white part of peel[3].'

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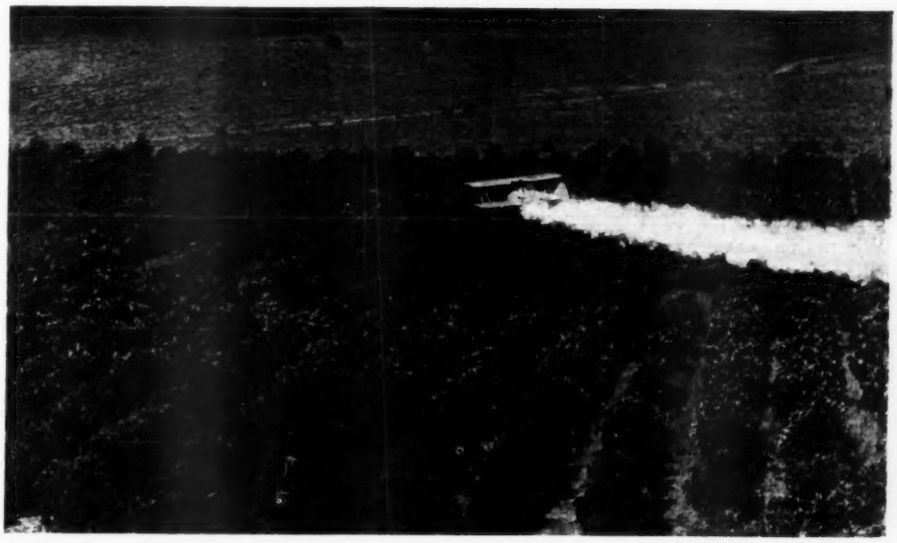
(Abbreviated from *Tropical Agriculture*).

Aircraft in Israeli Agriculture

Large-Scale Treatment in a Small Country

J. PALTI

In Vol. III of WORLD CROPS *we published an article describing efforts to introduce dusting and spraying by aeroplane in Israel. This paper by the same author discusses the results of further experience in the same connection.*



Dusting citrus is a typical job which can be carried out by aircraft in Israel

THE benefits agriculture can derive from the use of aircraft are already so widely known that they need no reiteration here. However, it is a fact that outside America aircraft are coming into agricultural use only very slowly; this would appear to be due largely to organisational difficulties in countries with medium to small farm units. The aircraft is, of course, basically a means for the large-scale treatment of wide areas, and its use is more economical the wider these areas are. But this by no means implies that aircraft cannot be used in smaller countries. Three years' continuous commercial operation of agricultural aircraft in Israel has taught us the ways of securing the benefits of aerial treatment in a country which is not only small in itself but has also for political reasons been cut off from its nearest neighbours. Some of the uses to which the aircraft were put during the initial period of operation have been described in a previous article (WORLD CROPS, **3**, p. 104). The present account deals mainly with operational and economic problems encountered.

Seasonal work

In large countries aircraft often find extended seasons for the treatment of a given crop by following the successive sowings of such crops, first in more southerly and then in more northerly regions, or vice versa. Thus, in the United States some of the aircraft operators in the mid-west and east-coast States move their operations for the winter season to Florida and other southern States. But in a small country climatic differences between various regions are not large enough to permit this staggering of seasonal work, and the period for effective treatment of each crop is more or less simultaneous everywhere, and therefore relatively short.

In order to make the most of these short seasons, the aircraft operator should possess a good agricultural scouting service to notify him promptly where and when crops are in a stage suitable for treatment. To avoid as far as possible a sudden mid-season rush of orders, which can then be filled only partly, it is of paramount importance to get early orders for those fields which can effectively be treated early in the season, and it pays to attract early customers by price reductions, etc.

The importance of an adequate number of aircraft standing by cannot be overemphasised. In work over long seasons losses incurred by mechanical failures or accidents can eventually be retrieved, but in short season work such interruptions may make all the difference to the operator's calculation. Loss of work through non-availability of aircraft must therefore be ruled out, and at least one aeroplane must be kept in reserve for every two planes working. Similarly, a pilot must be kept in reserve to take over if one of the regular pilots falls ill.

Versatility

It is only by extreme versatility that the agricultural aircraft operator working in a small country can make up for its limited acreage of single crops and length of season. Every type of treatment that can economically be performed by aircraft must be carried out, including spraying, dusting, fertilising and seeding. This implies constant alertness of the operator's agricultural staff to provide work wherever soil or topographical conditions, density of growth or suddenness of pest outbreaks gives aerial work an advantage over ground work. To exploit all possible openings the aircraft must also be as versatile as possible in its application equipment as well as in its operational qualities.

Thus each aircraft must be readily convertible for dusting, seeding and spraying. Now, combination rigs installed on aircraft to be used for either type of work, as the occasion demands, usually have smaller volumes and payloads than specialised rigs on aircraft used exclusively for dusting or for spraying. In addition, where belly-tanks are used in the combination rig, this involves certain aero-technical disadvantages and somewhat reduces the manoeuvrability of the aeroplane. However, in a small country these drawbacks are outweighed by the fact that all the aircraft can be used for any type of work during the peak season.

Some chemicals are objectionable or dangerous in aerial work, among them sulphur. But in Israel about half the total amount of work available consists of sulphuring orange groves and vineyards, and economic operation of the aircraft without this work is out of the question. To reduce the fire risk sulphur is applied mixed with an inert material (kaolin) which reduces the flash-point. The importance of sulphuring alone would have been

enough to rule out the use of helicopters in Israel agriculture, since to the best of our knowledge no helicopter has so far been licensed for sulphur dusting.

Economic considerations

The size of investment required for agricultural aircraft operation, as viewed in relation to the scope of work in a small country, and taken in conjunction with the abnormal risks of accidents and crop damages inherent in such operations precludes quick financial returns, and probably renders the work of more than one organisation in the country impracticable. Where this is the case the private operator labours at a disadvantage compared with public bodies. In the first place, most governments are reluctant to accord monopolies to private agencies. But secondly, and this is more important, only a non-profit making body can permit itself to calculate the cost of the operation in a manner benefiting the country's agriculture to the full; in the private operator's calculation the vagaries of climate, pest outbreaks, accidents and crop damages loom so large that he always arrives at relatively high cost prices. A public body may here take a larger view, spread the risks over many more years, and thus arrive at substantially lower prices.

Now many of the desirable aerial operations in agriculture, *e.g.* many types of fertilising, will not repay a high outlay. But by its lower initial price a non-profit making enterprise may here attract a great deal of work highly beneficial to local crops; the increased volume of work in its turn causes prices to spiral downwards, with added advantages to the farming community. Thus, provided they can muster personnel of the high order of initiative, enthusiasm and flexibility essential for this work, it appears to us that in a small country agricultural aircraft operations may advantageously be run by a non-profit making public or semi-public body.

Brazil's Rubber and Jute Increases

Brazil is becoming self-sufficient in rubber and jute, according to recent reports from the International Federation of Agricultural Producers. The Amazon region is increasing its production of these two commodities. Rubber production last year jumped by 28% and Brazil expects it will need no rubber imports in 1953. Jute production, begun five years ago, may reach 1,500,000 lb. this year.

A Caterpillar DW20 tractor pulls 16 sleigh loads of 400 tons of logs over a 50-mile ice and snow road from the lumber company's skidways to the mill

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Trade Publications Received

Four new booklets on, respectively, **'Caterpillar' Bulldozer Line, Caterpillar No. 64 and No. 42 Toolbars, Farming in the Corn Belt** and **'Caterpillar' Diesel Cotton Gin Engines** have recently been added to the already wide range of informative literature issued by the Caterpillar Tractor Co. of Peoria, Illinois.

The first-named is a 36-page catalogue describing every size and style of bulldozer made by Caterpillar, together with bulldozer attachments such as brush, root and rock rakes, the tree-dozer and the stumper.

Six International diesel engines and power units ranging from 45 to 180 h.p. are described in a new folder issued by the International Harvester Export Company (Publication No. E-96-B). A variety of photographs illustrate some of the uses to which these engines may be put, including sawmills, grain elevators, cotton gins and water pumps.

Fumite Insecticidal Smoke Generators and Pellets are described in a new four-page leaflet issued by WAECO Ltd. (Fumite Division). These generators and pellets are balanced mixtures of insecticide, oxygen generator and fuel, designed so that the oxygen supplier when kindled supports combustion of the fuel and the heat evolved is adjusted in amount so that it is just capable of vapourising all insecticide present.

Halservice for 1953. Besides being a catalogue of supplies and services of John W. Halse Ltd., of Honiton, this is a useful book of reference containing 86 pages and listing the facilities of the various departments of this Devonshire firm, namely, corn and seed, buildings, tractor and implements, repairs, machinery sales and spares.

The Complete Spraying Programme, 1953. This is the latest issue of the handbook brought out each year by the Murphy Chemical Co. for the fruit grower, hop grower and market gardener. Recommendations have been revised and brought right up to date. A fully descriptive list of all Murphy products is given, followed by detailed spraying programmes for fruit and vegetable crops.

Wolseley Electric Fencer Instructions. A new free booklet covering the whole aspect of electric fencing, available from the Wolseley Sheep Shearing Machine Co. Ltd. The booklet is illustrated. **Electric Fencing for Pigs** is a further booklet containing particulars of schemes for enclosing pigs together.

We have received from Rotary Hoes Ltd. a copy of their new **Rotavator Pictorial.** It is designed to show the rotavator owner how to get the best out of his machine and provides him a medium for exchanging his ideas with Rotavator-owners in other parts of the world. It will be issued free each quarter to every Rotavator owner who sends in his name and address, and to others interested in rotavation as a method of cultivation.

NEW BOOKS

Marginal Land in Britain

By W. Ellison. Pp. 224, illustrated. Geoffrey Bles, London, 1953. 25s.

The author of this book, Dr. W. Ellison, is Professor of Crop Husbandry in the University College of Wales, at Aberystwyth, and is well known in connection with his work on the reclamation of marginal land in Britain. In this journal we have previously reproduced an article from his pen dealing with reclamation of hill farm land in Wales (WORLD CROPS, II, p. 341).

With the increasing need for producing as much as possible of the food which Britain needs from her own lands, and reducing to a minimum the food imports, the improvement of her marginal lands immediately assumes much greater importance than was attached to it in earlier decades.

Consequently, this book, which seeks to compress between its covers a summary of experience during the past few years in reclaiming such lands and making them productive, is of more than passing importance.

Obviously any increase in supplies of home-grown food can only be achieved by making the best possible use of the limited area of land available, and when it is realised that a goodly proportion of the marginal land existing is not only making a negligible contribution in this regard but is also yielding considerably less than it did in days gone by, clearly the improvement of British agriculture to make use of these neglected assets is a matter of impelling urgency.

In his book Professor Ellison has made the attempt to collect and collate available information, to give an overall composite picture of the position, and has supplemented his own wide experience of the hill lands of Wales by consultation with numerous distinguished workers in other aspects of the same subject.

The first three chapters of the book are concerned with various aspects of the problem. The fourth chapter deals with the improvement of marginal land and the methods employed. Basing himself on Stapledon's and Davies' grassland map of England and Wales as a framework in which marginal lands can be classified, he discusses the various aspects and the steps which can be taken to improve matters, including cultural measures, cropping rotations and the use of fertilisers.

The remaining chapters of the book are occupied with such matters as raising the productivity of marginal lands under different conditions, the making use of increased productivity when attained, the application of these principles in store cattle-raising areas and a number of other special points.

The book is well and readably written. Indeed, one can say that one can read it for pure pleasure as well as for the store of learning on the subject that the author displays.

It is illustrated by some 41 plates, well reproduced and chosen to portray many of the points discussed. There are also a number of maps and graphs which further illustrate the arguments brought forward.

The book can be cordially recommended not only to farmers interested in the problem of reclaiming marginal land in Great Britain but also to those concerned with similar problems in their overseas aspects.

The Soybean Industry

By R. A. Goldberg. Pp. xv + 186. The University of Minnesota Press, Minneapolis (London, Geoffrey Cumberlege). 40s.

This book is not, as its title might seem to indicate, a comprehensive account of the production of soya beans throughout the world, but a discussion of the competitive position of the producer of soya beans in the State of Minnesota, where production has developed with great rapidity during the last few years. Actually, it is claimed that Minnesota now ranks sixth among the States of the U.S.A. in which soya beans are grown.

Certainly the growth of soya bean production in the U.S.A. has been phenomenal. Formerly the bulk of the world's production came from Manchuria, but war conditions and political unrest have combined to reduce production there and America has stepped in to fill the breach and to create new demands for this probably most remarkable of the leguminosae.

The book itself, within its narrow self-imposed limits, is packed with information about the production and the economic status of the soya bean crop in Minnesotan economy. We learn that in an economy which was formerly centred on maize and oats, production has now switched over to one based jointly on maize, oats and soya beans. We learn also that soya beans are at present about the most paying crop that the Minnesota farmer can grow; also that while Minnesota soya beans are lower in oil content than some of their competitors the geographical location of the State gives processors of soya beans an advantage over their competitors.

Almost inevitably in his preoccupation with the Minnesota industry the author cannot escape providing, almost unwillingly one inclines to suspect, a good deal of information about the world production and utilisation of the crop.

Little or nothing is said about the practical problems of growing and manipulating the crop, and one could have wished that the author instead of utilising his obviously great knowledge and ability in turning out a work dealing with only one small aspect of soya bean production had been inspired to produce an authoritative work embracing all aspects of the production of this important crop in all the countries where it is grown.

Plantation Crops, 1952

A Summary of Production, Trade and Consumption Relating to Sugar, Tea, Coffee, Cocoa, Spices, Tobacco and Rubber, with Appendices. Pp. xii + 120. H.M.S.O., or from the Commonwealth Economic Committee, London, 1953. 5s. (5s. 3d. post free).

Of the seven volumes which go to make up the Commodity Series published annually by the Commonwealth Economic Committee and which provide in summarised form statistical and other data concerning the main agricultural products of the world, probably that which contains the largest amount of information of direct interest to readers of WORLD CROPS is 'Plantation Crops,' giving concise data concerning production trade and consumption for sugar, tea, coffee, cocoa, spices, tobacco and rubber.

The most recent volume under this title has recently appeared and like its predecessors and the other members of the series is an invaluable epitome of information which should be in the hands of all actively interested in these products. From it we abstract the following information, relative to the world position in regard to these commodities in 1951-52.

World output of some major crops such as sugar, tea, tobacco and rubber, continued to expand during 1951. Exports of all these commodities, except sugar, rose also, and although world exports of sugar declined, supplies from Commonwealth sources were well maintained. The United Kingdom was again the world's largest market for tea and tobacco, with the United States the chief importer of sugar, coffee, cocoa and rubber. Commonwealth countries supplied practically all the United Kingdom's tea, cocoa and rubber.

For some of the chief commodities the production figures record a very large increase as compared with pre-war. The expansion was greatest in the case of rubber, for which the output in 1951 showed an increase of over 80%; sugar

and tea production rose by approximately 25%, but the output of coffee and cocoa was at much the same level as before the war. The Commonwealth produced the bulk of the world's tea, nearly half of the world's rubber, and more than half of the world's cocoa. For the two former commodities Commonwealth output in 1951 was half as great again as before the war and there was an increase of one-third in the Commonwealth production of sugar.

World exports of sugar and coffee in 1951, though below the post-war peaks, were above the pre-war average, but cocoa exports showed some decline as compared with pre-war. Shipments of tobacco from Commonwealth countries were nearly two and a half times the pre-war average, while those of rubber and tea were half as great again as the pre-war figure; over the same period Commonwealth exports of sugar and coffee rose by one-quarter. The Commonwealth maintained a large export balance for tea, rubber and cocoa, and these commodities, with sugar and spices, were among the chief dollar-earning products of the sterling Commonwealth.

Plantation crops continue to find their chief export markets in the United Kingdom and the United States.

Although the United Kingdom draws from Commonwealth sources nearly all of its tea, cocoa and rubber, half of the coffee comes from foreign countries; these supply also a large proportion of its tobacco, though less so than before the war, Commonwealth countries contributing well over one-third as compared with about one-quarter formerly. The United Kingdom has, however, become more dependent on foreign imports of sugar, although imports of cane sugar are supplemented by a considerable domestic production of beet sugar. Relatively small imports of pepper, cloves, ginger and other spices are mainly from Commonwealth sources.

Divergent trends may be traced in the levels of consumption of these commodities. In the United Kingdom tea consumption per head in 1951, still restricted by rationing, was less than before the war, while in the United States *per caput* consumption kept pace with the growth in population; in both countries there was a very great increase in the consumption of coffee, but while that in the United Kingdom was under 2 lb. per head in 1951 the corresponding figure for the United States was over 13 lb. per head. By 1950-51 the domestic consumption of tea in India and Pakistan was running at about twice the pre-war figure. Sugar consumption per head in the United Kingdom in 1951, restricted by rationing, was lower than pre-war; in the United States and Canada it was at much the same level as pre-war, but in South Africa and Australia there had been a notable increase.

The recovery of production in Indonesia was an important factor in the expansion of world tea and rubber production in 1951; for tea another main feature was the increase in the output of the Commonwealth, which accounted for some 82% of world output (outside China and the Soviet Union) as against 68% in 1939. The marketing of sugar and tobacco was still to a large extent governed by currency difficulties; the increase in sugar production in dollar-account countries, especially Cuba, led to problems of disposal, while larger output in the sterling Commonwealth was envisaged by the 1951 Agreement between the United Kingdom Government and representatives of Commonwealth sugar producers. Tobacco output in several Commonwealth countries showed a continued increase, under the need to restrict dollar purchases; nearly one-half of United Kingdom imports of unmanufactured tobacco in 1950 came from the sterling Commonwealth.

To Authors and Readers

The Editor and publishers of WORLD CROPS will be glad to consider manuscripts of books submitted for publication. We already publish a number of books on technical subjects, all of which find a world sale, and most call for regular reprints and new editions.

Books of a non-fictional type in any language by any publisher can be supplied by the Book Department of WORLD CROPS.

Farm Incomes

In England and Wales. Farm Income Series No. 4, covering the year 1950-51 with some reference to earlier years. Report based on the Farm Management Survey. Pp. 71. H.M.S.O., 1953. 6s. 6d.

The latest report, based on the Farm Management Survey and comparing financial and economic results for 1950-51 with the previous year, is now available to the public. An identical sample of 2,303 farms from 13 type-of-farming groups provided the data for the survey.

Results indicate that in 1950-51 there was a slight decline in net incomes of about 5% compared with 1949-50, the drop being carried mostly by farms whose economy is based on livestock production; mixed and arable groups on the whole maintained the profits of the previous year. Changes in profitability related to all size groups and were not confined to any particular acreage, although there was some indication that the greatest decline was sustained by large farms of more than 500 acres.

Expenditure rose by an average of 8% for the 2,300 farms, varying from 16%, or £7 an acre, on the small dairy farm, to 4·5%, or £0.9 an acre, on the large livestock fattening farm. Feeding stuffs became the largest single item of expense in the dairying group, thus relegating labour costs to second place, 29% of the total farm expenditure on these farms being accounted for in purchases of feeding stuffs. The total annual expenditure on machinery (new purchases, repairs, fuel, taxes, insurance and contract services) rose from £5.6 to £6.0 per acre, equivalent to 22% of the total farm expenditure.

There are altogether 43 tables of statistics relating to the survey, including this year two bar charts showing the relative importance of different items of farm revenue and expenditure. These charts certainly relieve the monotony of the extensive tabular material which, as we mentioned when reviewing last year's report, become somewhat of a strain to work through.

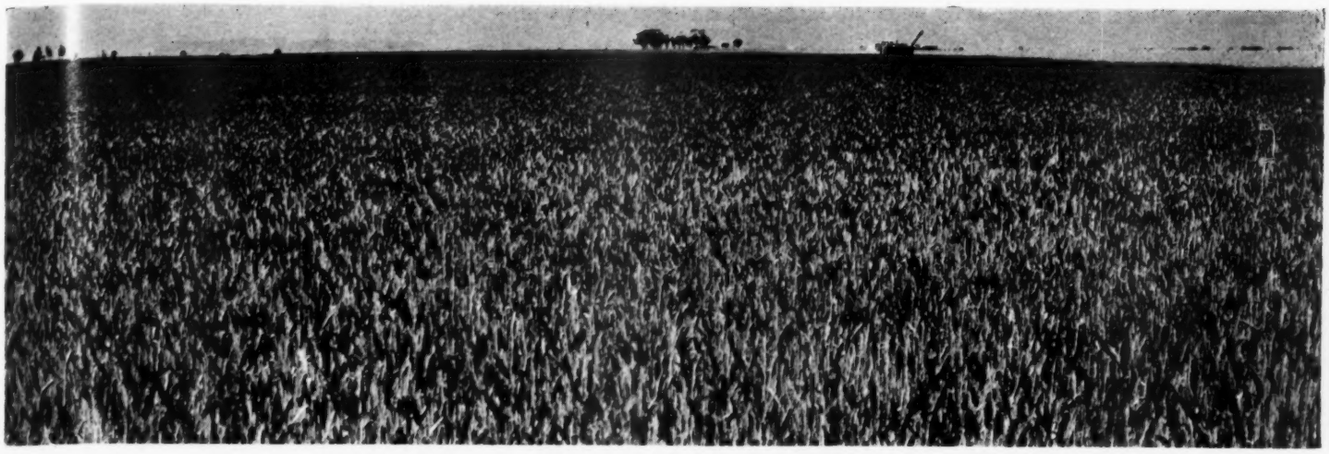
The material within these reports is of value and could be of much greater value were the topicality of this information not lost to a great extent because of the gap between the period under review and the date of publication. In this case nearly two years have elapsed and, one would think, this length of time could reasonably be reduced with a consequent increase in value of the reports.

Poultry Breeding

By A. L. Hagedoorn and Geoffrey Sykes. Pp. 240, illustrated. Crosby Lockwood, London, 1953. 18s.

This book, which is the product of the joint labours of an expert in genetics and a practical poultry breeder, will no doubt receive a warm welcome from poultry breeders in Great Britain and also overseas.

The book is well written and copiously illustrated, while it seems to provide an easily comprehensible guide to the intricacies of the genetic problems which confront the breeder as well as providing guidance on the practical aspects of the subject.

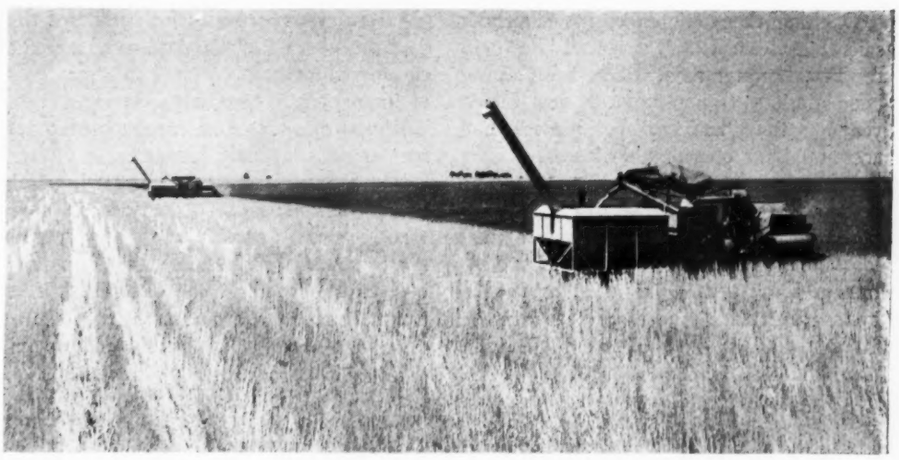


Summer winds scorch and rattle the fat hard grain heads of Australia's wheat crop. Wheat is second only to wool in importance in the Australian economy and is one of its biggest items of international trade

The Australian Wheat Harvest

An article on the wheat crop of Australia, by L. T. Sardone, recently appeared in WORLD CROPS (*January issue,* 1953)

Seven bountiful wheat seasons in a row in Australia since the war have given 176,000,000 bushels a year. A high yield per acre has tended to hide the disturbing fact that the acreage under wheat is steadily declining. (*Above*) **Toothed 'headers' harvest wheat in the Wimmera wheat belt of N.W. Victoria, one of the major wheat-producing states.** (*Below*) **These combine harvesters lead the grain into awaiting trucks through screw-augered pipes. Grain trucks discharge their loads into concrete silos north-west of Melbourne** (*below right*)



CONFERENCES AND LECTURES

Some Problems of Sugar Beet Production in Britain

ADVISORY SERVICE SUGAR BEET CONFERENCE HELD AT PETERBOROUGH

PETERBOROUGH, the centre of an important sugar beet growing area, was the venue for a recent conference organised by the National Agricultural Advisory Service on 'The Sugar Beet Crop.' The chairman was Mr. Oswald Rose, agricultural Development Officer for the British Sugar Corporation, and the two speakers were Dr. R. Hull of Rothamsted, who is in charge of research work associated with virus yellows disease of sugar beet, and Mr. P. N. Harvey, until recently closely associated with sugar beet cultivation research at the Norfolk Agricultural Station.

The virus yellows problem

Opening the conference, the chairman said that virus yellows was well known in the Peterborough area, although it had not been unduly troublesome during recent years. 1945 and 1949, however, had accounted for considerable losses.

Referring to the £2½ million that had been given out by the Ministry in compensation for foot-and-mouth disease losses, he pointed out that virus yellows has in some seasons resulted in just as great a financial loss to sugar beet growers. In this country, he said, around 400,000 acres of sugar beet are grown, besides 300,000 acres of fodder beet and mangolds, which are also susceptible to the virus.

Following the colour film 'The Yellows Story,' produced by the British Sugar Corporation and directed by Dr. Hull, the latter then described some of the progress that has been made in trying to fight the disease.

In 1949, he said, virus yellows appeared in 50% of the British sugar beet crop. This involved the loss of nearly 20% of the beet sugar yielded, amounting to a million tons by weight or £5 million in cash. The following year there was very little virus (5½% of the crop), and in 1951 even less (1½%). Last year, however, the incidence of the green aphid vector was ten times greater than in previous years and the disease began to be fairly apparent last autumn. This may mean widespread incidence in the current year if a heavy aphid infestation develops in the spring, because these aphids would then be able to carry the disease from remnants of the 1952 crop to the young 1953 crop.

Dr. Hull advised stock owners to ensure that mangolds and sugar beet tops are cleared up before April to prevent the disease being spread from the roots to young sugar beet. Experiments are being carried out on spraying mangolds with an insecticide before lifting and in the use of sprout repressants on mangolds in the clamp.

Early sowing is emphasised and measures to ensure rapid and early development of the crop encouraged. High plant populations often have less infected plants.

The virus, said Dr. Hull, has increased in prevalence generally throughout Western Europe during the last decade.

Factors affecting incidence

The extensive cultivation of the beet family during the last 15 years or so has given every opportunity for spread of the disease; over 5% of the surface area of the eastern counties is cropped in sugar beet or mangolds. Similarly, during recent years there has been an emphasis on other root crops, especially fodder beet.

The area of beet grown for seed, which overwinters between two seasons, is much greater than formerly and now covers about 4,000 acres. Also, the increasing cost of labour has necessitated farmers employing such labour-saving devices as clamping mangolds with their tops on, and using mechanical harvesters, which leave some roots in the ground; both these practices favour the carry-over of aphid populations.

Farming changes have unwittingly encouraged the incidence of green aphids, *e.g.* more brassicae are grown in the winter, thus giving the pest more plants on which to overwinter.

The British Sugar Corporation is introducing measures to prevent the spread of the disease from the commercial crop to the seed crop by growing the seed crops in disease-free areas. This resulted in 1952 in 0.7% of the seed crops showing signs of disease; before this seed crops were practically all affected to a certain extent. Seeds from disease-free beds have yielded over 50% more beet than the previously used commercial seed.

So far, Dr. Hull ended, no virus-resistant varieties of sugar beet have been found, although much effort is being directed towards this end.

Discussion

When asked whether it was advisable to increase the use of nitrogenous top dressings in order to counteract the disease, Dr. Hull replied that there is no evidence that nitrogen reduces loss from the virus. The crop may look cleaner, but experiments on infected crops with and without applications of nitrogen have shown that there is no difference in sugar yields.

Whether feeding sugar beet tops to stock is less likely to reduce the risk of carrying aphid vectors over to another season than ploughing them in is a moot point. Stock feeding certainly eliminates any danger, but at the same time there is no evidence that aphids can survive on the crown in the ground. The speaker's opinion was that the best way was to feed all crowns and tops to livestock.

Could stecklings, planted in the autumn, be affected by a commercial crop not yet harvested? Aphids do continue to move about during a mild autumn so the planting of stecklings should be delayed until November.

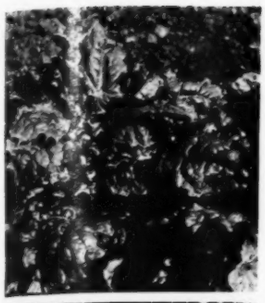
Beet cultivation developments

The next speaker, Mr. P. N. Harvey, described some of the work which has been carried out on methods of sugar beet cultivation. The problem now after 30 years' experience in growing crops, he said, is to cut the cost of growing, which means, in effect, the labour peaks of spring thinning and harvesting.

Discussing thinning standards, Mr. Harvey considered that, although possibly slovenly looking, doubles don't have much effect on the yield. Trials in 1951 showed that the yield did not fall even with 60% doubles. However, handwork on topping and to a lesser extent lifting takes longer in proportion to the number of double roots present.

Aids to speeding up singling include reducing the seed rate from, say, 15 to 10 lb. per acre. Segmented seed, Mr. Harvey said, has now been discarded, but rubbed seed, which produces far fewer double and treble plants, gives a 10% saving in singling labour and no loss of vigour or growth. 11 lb. of rubbed seed are equivalent to 15 lb. of natural seed per acre and therefore, taking this into account, the extra cost of rubbed seed per lb. is no disadvantage.

There is also available small rubbed seed, which undergoes a more severe processing than rubbed seed; it passes through a ¾-¾ in. sieve compared with the ¾-¼ in. size for ordinary commercial rubbed seed. In 1951 a 20% saving in



A healthy sugar beet plant

Sugar beet plant infected with virus yellows

Photos: British Sugar Corporation Ltd.

singling labour was effected by using small rubbed seed, but germination was reduced generally. Therefore, small rubbed seeds must still be considered as in the experiment stage for the time being.

Pelleted seed unfortunately delays germination.

Seed control

Experimental weed killing in the row by using pre-emergence weedkillers has not so far given conclusive results.

In America the current idea is to sow rubbed seed fairly thickly and thin it out by various machines such as weeders and side delivery rakes in successive stages until the stand is thinned, finishing up with a quick hand hoeing.

Mr. Harvey, explaining 'down the row' thinning, said that these machines were now used extensively in America. These blades, driven from the land wheels, gap the row as the machine moves along. Design, however, has not reached finality.

Cultivation problems

In the discussion that followed it was pointed out that sometimes as good a yield can be obtained from a plant population of 25,000 to the acre as from the officially recommended 30,000 per acre; 20,000 plants per acre would not, however, give so good a yield.

Asked about a single germ seed, the speaker mentioned that the American growers have such a seed which is to be used commercially in the coming season. It is reported that the germinating power is reasonable although yield trials so far are not quite up to the standard of commercial varieties. There is growing optimism about the introduction of this seed in America.

The National Institute of Agricultural Engineering

AT a meeting of the Institution of British Agricultural Engineers, held recently in London, Mr. W. H. Cashmore, Director of the National Institute of Agricultural Engineering, read a paper on recent and present work at the Institute. A summary of the paper and discussion which followed is given below.

Introduction

The National Institute of Agricultural Engineering was set up in 1942 at Askham Bryan, Yorkshire. Its main work was to provide technical advice to the Ministry of Agriculture, for which purpose a number of *ad hoc* investigations were made and a comprehensive testing scheme was initiated.

In 1947 the N.I.A.E. became a state-aided Institute under the control of the Agricultural Research Council, and moved to permanent quarters at Wrest Park, Silsoe, Bedfordshire. The programme was changed to include investigations, research and development, in addition to testing.

Testing

As a service to manufacturers some 80 tests a year are carried out, covering practically all field and barn machinery, with the exception of dairy equipment. It is hoped, in time, to evolve standard tests for all the main classes of machinery and one of the functions of the testing staff is research into testing techniques. Standard methods of testing have already been drawn up for tractors, grass and grain driers and hammer mills. There are provisional schemes for ploughs, fertiliser distributors, potato planters and potato harvesters, and sugar beet harvesters.

Manufacturers use the official testing scheme in place of a testing department of their own, or as a means of obtaining a check on their own results. The test reports are used for assisting firms' staffs engaged in the development of new machines or components for commercial purposes, and to provide evidence for certain overseas countries before they will accept imported machinery.

Investigations

As far as possible N.I.A.E. development work is preceded by an investigation into the problem, so planned as to give results which can be made applicable to other specified conditions. The results may indicate a more efficient farm technique using existing equipment, or they may indicate the need for new or improved machinery. In the latter case the data from the investigation is made available to development staff whether of firms or at the N.I.A.E.

Development and research

Where possible N.I.A.E. development is based on the results of investigations and research, but in some cases where this is not possible—as, for example, implements dealing with the soil—the development starts as a lash-up in the blacksmith's shop and is modified and rebuilt as work in the field progresses. In all cases development is closely associated with experimental work, so that although a machine may be designed for a special set of conditions, there is some information on which to base modifications for other required conditions. At all stages in N.I.A.E. development work there is close contact with interested manufacturers so that any benefits to be derived from the N.I.A.E. work reaches the farmer in the quickest possible time.

The Institute designs and builds special equipment and apparatus for measuring and recording the performance of machines. Experimental machines are also designed and built to meet the requirements of other research stations. If the results of such research justify the manufacture of a new machine, the N.I.A.E. can pass on details of design essential for production models.

The general programme of work, which is agreed with the Agricultural Research Council, is based on requests from various sources, including A.R.C. conferences on specific problems, Ministry of Agriculture Advisory Committees, Government Working Parties, Trade Research Associations, and N.I.A.E. departments.

Examples of work in progress

Investigations into the process of haymaking and the use of haymaking machinery, and the mechanical down-the-row thinning in root crops, show how fundamental data may indicate new techniques, or the need for new or improved machines.

The investigation into American-type down-the-row root thinners commenced as a Record of Trial on a machine imported from the U.S.A. The work began on the beet crop and has included close measurements on a number of small plots, linking up performance, measured as the

saving in singling time, with such factors as rubbed or natural seed, high or low seed rates. Other measurements include the plant population at varying stages, and the final yield. The plot experiment was followed by a field scale experiment in 1952.

Preliminary results indicate the possibility of an appreciable saving of labour without an associated loss of plant population, or regularity in the rows, but considerable skill and field experience with a fair range of adjustments on the machine seem to be essential.

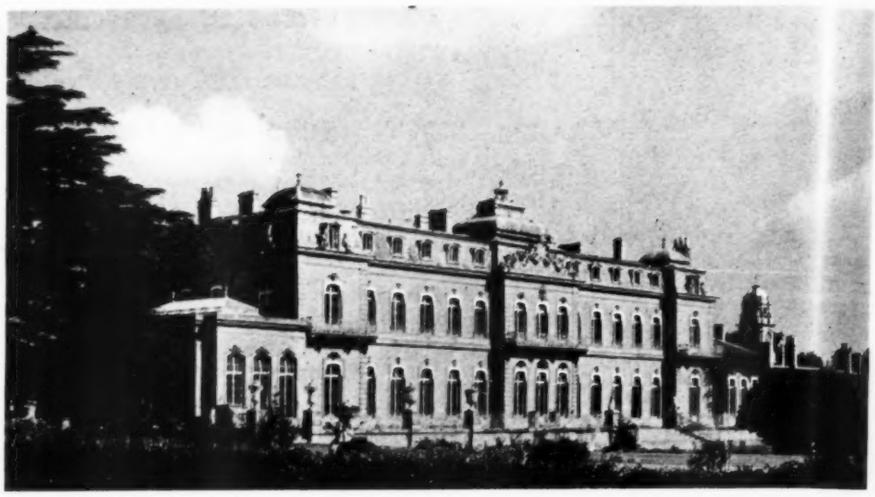
Development includes a groundnut harvester being tried out in East Africa, its design being based on experience with potato harvester development; grain-drying equipment based on investigations; and laboratory research into the properties of grain. Long-term development is covered by work on a hydraulic powered tractor which, if successful, would revolutionise farm power, and in particular the design of self-propelled implements.

Work on grain drying serves as an example of how improvements in design are brought about. Earlier research work had established two systems for dealing with amounts of grain which do not justify the purchase of a standard grain drier—the platform drier and the ventilated drying silo. In each case the main lines of plant layout have been accepted after extensive trials on farms and the N.I.A.E. work on this subject is now mainly concerned with details of equipment, aiming at improved performance.

In 1949 three platform driers were placed on farms, and by the 1952 harvest there were some 750 plants in various parts of Britain. As a result of consultations with the N.I.A.E., a platform drier has been installed at the Empire Cotton Research Station at Kampala, Urambo, Tanganyika, for drying cotton seed and maize; another has been used by the Sudan Government at Juba for drying sorghum and an experimental unit will be operated in Tanganyika in connection with the development of a groundnut harvester, in co-operation with the Overseas Food Corporation.

Horticultural work mentioned in the paper includes the steering design of horticultural tractors, low volume spraying, and a glasshouse heating and ventilating investigation, aimed at improving the overall efficiency, and at providing data and planning recording equipment for other glasshouse research.

The Scottish Machinery Testing Station, set up as a sub-station of the N.I.A.E. in 1947, operates the same testing scheme, and its programme fits in with the main one, with the addition of special problems applicable to Scotland, such as the behaviour of implements on sidling land, and the control and eradication of bracken.



Southern aspect of Wrest Park, headquarters of the National Institute of Agricultural Engineering, in Bedfordshire

Conclusion

Much of the benefit of the Institute's work reaches the farmer indirectly. Testing prototypes for manufacturers and the provision of basic information to assist design is seldom brought to the attention of farmers, and would be of little practical interest if it were. On the other hand, published test reports, reports on investigations and techniques, and the performance figures obtained by the Institute in co-operation with other organisations in national competitions, do provide useful information for the farmer. In some cases reports are written in a scientific or technical form, but the N.A.A.S. is able to interpret these reports to meet individual cases.

The Institute is now making contact with many overseas countries, including the Dominions and Colonies. Visits are exchanged and it is hoped that as a result it will be possible to provide general information and special testing facilities to assist manufacturers in their efforts to increase exports.

Discussion

Opening the discussion, **Lord Radnor,** Chairman of the N.I.A.E. since its inception, paid tribute to the work and enthusiasm of Mr. Cashmore during his 30 years as an agricultural engineer. Lord Radnor stressed that the Institute is still in its formative stages and techniques for experimental work are continually being improved.

Other speakers who complimented Mr. Cashmore included Messrs. **Roland Dudley, F. W. Daniels** of the Ford Motor Co., **C. B. Chartres,** past president of the I.B.A.E., and **A. G. Cameron Brown** of the British Electricity Authority.

Mr. J. R. Moffatt of Rothamsted Experimental Station, speaking as a research worker, acknowledged the help received from the N.I.A.E., which enabled experimental programmes to be expanded.

Sir Harold Tempany hoped that the N.I.A.E. would, in due time, expand its activities to cover the overseas colonial territories of the British Commonwealth and suggested that a Commonwealth Bureau of Agricultural Engineering could usefully be set up at Silsoe following the lines of the existing 12 Commonwealth Agricultural Bureaux.

Many overseas countries' organisations were in close touch with the N.I.A.E., said Mr. Cashmore after the discussion, and ideas on testing techniques were being exchanged.

WORLD CROPS

OUR NEXT ISSUE will contain a number of articles on rubber, including **The International Organisation of Research and Development in the Natural Rubber Industry,** by Dr. Geoffrey Gee, F.R.S., and **The Rubber Research Institute of Malaya,** by C. E. T. Mann, M.Sc. The present stage in the development of **systemic fungicides** will be a further article in this issue. There will also be other articles and regular features as usual.

RESEARCH DEVELOPMENTS

Soil Improvement Research in France

A GOOD deal of attention has been bestowed on synthetic resins and allied compounds as soil conditioners of late years, especially through the work in America of the Monsanto Chemical Co. in relation to the compounds of this class which they have lately publicised under the name Krilium. The versatility of the synthetic resins and related compounds in a similar connection has been further exemplified in recent years by the work of S. Henin and his co-workers in France, especially with salts of polyacrylic acid. A fairly full report of their earlier experiments was given in *Plant and Soil*, 1948, 1, 167-178, supplemented more recently by a paper read before the *Academie des Sciences*, in Paris, in January, dealing more fully with the polyacrylates (*Comptes Rendus*, 1953, **236** (1), 117-119).

Polyacrylic salts

These communications point out that the polyacrylic salts have been found very effective in small doses in improving soil stability and moisture-holding capacity. When finely powdered they are sufficiently soluble to dissolve and fix in the soil, showing considerable resistance to bacterial action, so that they remain stable and efficient for several years. In France attention has been specially directed to silty or sedimentary soils, *e.g.* horizons A and B that are notably unstable. Samples of dried soil were finely sifted (0.5 to 2 mm.), divided into several fractions, and impregnated with a solution of powdered acrylate by means of a vapouriser. Controls were treated with water only. The same amount of water was used in all cases, but concentrations of acrylate were varied.

After air-drying a definite weight of each sample was stirred in water for 30 min., and sifted over a 0.2 mm. sieve. The weight of particles thus recovered indicates resistance to the action of water. The results show considerable increase in water-holding capacity of the treated soil, and this is maximum for a 2% average addition. The percentage of 'stable' particles increases from 6 to 12% in controls, up to 70% in treated samples. Even with doses of the order of 1/10,000 there is a marked effect, with double or triple stable aggregate.

By way of comparison a soil which has received 100 tons/hectare (40 tons/acre) of farmyard manure per annum for 20 years exhibits a similar increase, while land which has been for three years under lucerne shows twice the amount of stable aggregate; or three times if under clover for six years. It has been shown earlier (*Plant and Soil*, 1, 167-178) that stability in the case of sedimentary soils depends mainly on two factors, cohesion and wetting power. The latter property (wettability) may be demonstrated by impregnating the soil before water-treatment with certain organic liquids—polar or non-polar. These treatments have been applied to soils that had received an average dose of the active product (acrylate), and to soils of a similar kind enriched with organic matter by application of farmyard manure. Tabulated results are as follows:

PERCENTAGE STABLE AGGREGATES (>0.2 MM.)

Treatment with—	*Nature of Soil*	*Without Pre-treatment*	*Pre-treatment with*	
			Carbon Tetrachloride	*Nitro-benzene*
Substance No. 657 ..	Horizon A	24.3	11.2	17.0
	,, B	17.5	4.8	7.0
Substance No. 659 ..	,, A	35.7	18.7	28.3
	,, B	31.5	4.3	8.7
Manure	None	7.3	3.4	5.8
	48 tons/acre for 20 years	23.3	16.9	23.1

It is clear that the stability of soils pretreated with the chemicals named is inferior to that of soils not so pretreated. But, on the contrary, those that have been well manured for 20 years show little diminution in aggregate stability by treatment with carbon tetrachloride, and practically none at all by treatment with nitro-benezene. It is concluded, therefore, that the effect of addition of improving agents should not be attributed to diminution of wettability—or at least to only a slight degree.

Increasing cohesion

Proceeding next to a study of resistance to crushing or abrasion (écrasement), that is cohesion, it has been found that the aggregation or cohesion of small particles of soil was easily doubled or tripled by addition of the active substance. Previous work many years ago (S. Henin, *Etude phys.-chem. de la stabilite structurale des terres*, Imprim. Nat., Paris, 1938, vol. I, 32-34) had shown that such variation could largely explain the observed increases in stability. Therefore, it is by increasing cohesion of soil particles that the products in question improved structural stability. Capacity for moisture-holding was also determined by drying under vacuum. Increases of 10-15% were obtained by applying polyacrylates to the extent of only 2-4/10,000.

Effect on germination

Finally it has been found that by diluting soil samples with water and collecting them over a Buchner funnel connected with a vacuum pump, the germination of wheat grains that had been introduced was rapid in the closely packed or compressed lumps of soil; whereas, in the controls it was much slower—only about half the sprouting plants showing above the surface. It is concluded that addition of these polyacrylates aids germination; but the mode of action differs from that of humus, so that it would not be wise to infer that they can replace humus entirely in the type of soils investigated. On the other hand, it will be necessary to establish by prolonged experiment whether the continued use of such materials is attended with counter-balancing drawbacks. There is also the question of costs. When it is possible to obtain these synthetics at lower prices this will, in the absence of any as yet undiscovered disadvantages, doubtless permit the fairly rapid restoration of overworked soils, including possibly compacted sub-soils.

W. G. CASS.

Record World Wheat Crop Expected

The world has about one-third more wheat available for export and carry-over than it had this time last year, the International Federation of Agricultural Producers reports.

Latest estimates indicate the supplies of wheat in the four major exporting countries amounted to 1,365 million bushels.

The world wheat crop is now estimated at 7,235 million bushels, the highest on record. The previous record was 6,610 million bushels in 1938-39.

Jute Investigations in British Guiana

As a result of investigations carried out in 1951, the British Guiana Fibre Research Co. Ltd. was formed in London in 1952 to conduct research on fibre crops in British Guiana. A subsidiary company, known as the Berbice Fibre Research Co. Ltd., was formed and registered in British Guiana on August 21, 1952, to carry out research, experiments and tests in connection with the production of jute. The latter company took over all supplies of jute seed available from the Department of Agriculture of British Guiana and assumed responsibility for future work on this crop. This Department had been responsible for research work on jute prior to the formation of the Company, on behalf of the Colonial Office.

Details of cultivation

Land on which to carry out research work was made available by Bookers Demerara Sugar Estates Ltd. at Plantation Rose Hall in the Berbice district. The cultivation of 157 acres of rough pasture was commenced towards the end of 1951 with heavy agricultural machinery. By April 1952 the area had been subdivided into nine blocks for irrigation and drainage purposes and pre-sowing cultivation had been completed. Dry weather facilitated the production of a fine tilth on all blocks and sowing was commenced in the second week of April and continued at intervals until early June.

The greater part of the area was sown broadcast by hand. A seed drill suitable for sowing rice was tried out but was found to be unsatisfactory due to its failure to sow seed sufficiently shallow. A hand broadcasting fiddle was used at the end of the planting season and proved satisfactory.

Seven varieties of jute were planted, of which three showed sufficient promise to warrant further large-scale trials in 1953. The remaining varieties and new varieties from the quarantine area at the Sophia Sugar Experimental Station will be planted out in small trials to confirm observations made in 1952 and to bulk up seed of the more promising recent introductions.

The majority of the jute planted received a top dressing of a complete NPK fertiliser. It would appear that fertilisers are required to obtain a crop of adequate height for fibre production. The height of the crop also appeared to be related to the spacing of the plants in the field. At a wide spacing, on application of fertiliser, one variety reached a height in places of 13-15 ft.

The thinning of hand broadcast crops was found to be expensive and necessary, while weeding could be dispensed with provided an even cover had been obtained. Good drainage was essential to satisfactory growth.

The 1952 crop was comparatively free from diseases and pests; the only pest of any consequence being a flea beetle causing superficial scarring of the bark and in severe attacks damaging the newly formed leaves near the growing plant. A leaf spot on over-mature jute was recorded, but did not appear to affect adversely the plant up to the fibre stage.

Jute (ECR 576) grown in the Berbice district of British Guiana

Treatment of fibre

Crop suitable for fibre was ribboned by machine in August after being cut by hand. The ribbon was subsequently sun-dried and trussed prior to storage in an open-sided building. Ribboning was satisfactorily carried out with the machine that had been used in Nigeria in 1951. A ribboning machine, specially designed for British Guiana conditions, was received later in the year and was tested with some late maturing jute. The performance of this machine was better than that of the previous model. It is clear that ribboning is a practical solution to handling the crop as it reduces the bulk requiring transport by about one-half.

The yield of green plant per acre suitable for fibre production appeared to be satisfactory as far as it is possible to judge without having retted the dry ribbon produced. Retting has not been commenced due to delay in completion of the retting tanks. The yield of seed of all varieties has been up to expectations and adequate stocks of seed are available for the 1953 crop.

In 1952 jute was found growing wild in a few localities in Berbice. Only one variety appears to be present in these areas. Ribbon of this local variety, named 'Murray's jute,' after the farmer on whose land it was first found, was tested by the British Jute Trade Research Association and found to be of satisfactory quality. During the last crop a small area was sown to bulk up seed and the crop attained a height considered satisfactory for fibre production.

International Bank Loan for Damodar Valley Scheme

On January 26, 1953, the International Bank for Reconstruction and Development announced that it had granted a loan of $19.5 million to the Indian Government towards the cost of certain projects included in its scheme to develop the Damodar River Valley. The loan is for 25 years and bears interest of 4⅞%. It will be used to pay for imported materials, equipment and engineering services needed in building two multi-purpose dams, each with a hydro-electric plant, and an extensive irrigation system including a diversion dam on the Damodar River. The hydro-electric plants will have a capacity of 100,000 kilowatts, the dams will help in protecting the surrounding countryside from floods, and the irrigation system will serve an area of 1 million acres in West Bengal and should make possible the production of an additional 400,000 tons of food grains, mostly rice. The main irrigation canal, 80 miles long between the Damodar River and the Hooghly River 30 miles above Calcutta, will be used by barges, which will provide a cheap way of transporting coal and other goods between the valley and Calcutta. The total cost of the works for which the Bank's loan has been given is estimated at the equivalent of $103 million; the additional foreign exchange needed, and also the local currency part of the costs, will be provided by the Government of India and the State Governments of West Bengal and Bihar.

FARM MACHINERY

Special Fluids Developed for Aerosol Application

The special formulations of agricultural chemicals for use in aerosol generating machines such as the Microsol generator, briefly referred to in WORLD CROPS last month, mark a further development in the expanding agricultural chemicals industry.

As mentioned last month, Pan Britannica Industries Ltd. have made a special study of this problem and produced a range of fluids specially formulated for dispersal in aerosol form. An aerosol, in effect, takes out the water in wet spraying and replaces it with air, thus producing a mass of finely divided particles which in the case of the Microsol '202' may be controlled in size from 5 to 60 microns (1 micron equals 1/25,000 of an inch diam.). The special fluids for this method of dispersal are based on the use of a highly volatile solvent such as acetone and one of the first requirements of an aerosol-producing machine is, therefore, that it must be completely flameproof.

Application rates by this method are low. For instance, the special fluid known as PCI(M), based on parachlorphenyl benzene sulphonate (PCPBS) is used on tomatoes, vines or carnations at the rate of 1 fluid oz. to each 3,000 cu. ft. of glasshouse in the early stages of growth.

Other aerosol fluids include AB40, a fortified azobenzene fluid for the control of red spider on cucumbers and melons; PM4, based on phenyl mercury preparations for control of cladosporium leaf mould and botrytis on tomatoes; DDT, BHC and nicotine have also been formulated as aerosol fluids, and a fruit-setting fluid for use on tomatoes.

Application techniques

When applying insecticides or fungicides in long houses of over 100 ft. in length it has been found that the optimum spread is obtained if the machine is carried from one end of the building towards the door end, timing the walk-through. In shorter houses the machine is stood about 12 ft. from the door, facing away from the entrance, and allowed to run. In this way enough air turbulence is caused to enable the discharge to float in the house for about an hour.

The fine mist of fortified azobenzene fluid soon obscures visibility in the glasshouse

The Microsol '202' generator in operation, producing a mist of 40-micron particles

The container capacity of the Microsol '202' is 3½ pints of fluid, enough to treat 90,000 cu. ft. of glasshouse area, or quarter of an acre under glass.

The ¼ h.p. electric motor drives the generator and operates the fan; the latter produces a 85-90 m.p.h. blast which shears off the fluid droplets as soon as they leave the machine.

Sprayer Price Reductions

Messrs. Cooper, Pegler & Co. have announced substantial reductions in the prices of most of their spraying and dusting machines. The 'Atomizer' 600, for example, a 45-gal. sprayer introduced last year, is reduced from £438 to £370. Similarly, the 'Arborex' 488, Model 11, with engine and tractor drawbar, is now priced at £322 15s., compared with £368 10s. last year.

Readers of WORLD CROPS will be sent a copy of the latest catalogue and price list, on application to Messrs. Cooper, Pegler.

Stored Grain Protection

U.S. Agriculture Department engineers are working on a cooling device which prevents insects and moisture damage to stored grain. It consists of a perforated iron pipe with a small fan mounted at one end. The pipe is inserted vertically in the centre of a bin of grain. When the fan is turned on it draws air through the perforations from the grain. This keeps moisture circulating evenly and prevents caking of grain and eliminates heat pockets.

A new liquid manure spreader, the Vaci-Tank distributor, consists of the 250-gallon tank filled by suction from the induction manifold volume of the tractor. The liquid is distributed by gravity feed on to a splash-plate type spreader, a spread of about 8 ft. being obtained

PEOPLE IN THE NEWS

Imperial College of Tropical Agriculture

It has recently been announced that the Governing Body of the Imperial College of Tropical Agriculture in Trinidad have appointed Dr. G. C. Herklots, Secretary to the Colonial Agricultural Research Committee, to the post of Principal, which has been vacant since October last consequent on the resignation of Mr. Harold J. Page, C.M.G., who had accepted an appointment under FAO in Rome.

Dr. Herklots has filled his present post during the past three years, during which period he has visited a number of the Colonial Dependencies. Prior to that he was Reader in Biology in the University of Hong Kong. He was made a prisoner during the Japanese occupation of Hong Kong, and on the reoccupation of that territory by the British he officiated as chief of the agricultural services there, in which capacity he rendered notable services in connection with the rehabilitation of the agricultural and fishing industries.

Ferguson Help in Flood Relief

To help in securing the sea defences and in getting the water off the land as quickly as possible the Ferguson Organisation is bringing special trench-digging equipment to the East Coast of Britain from France. Several timber sledges of an advanced type and half-track equipment and caliper grabs designed to be used with Ferguson tractors are being shipped from Sweden and Denmark to Scotland, where they will be used in the work of extracting timber from the flattened forests of Aberdeen and Kincardine. A Swedish forestry expert will be arriving in Scotland shortly to give technical advice.

An emergency conference was held in London to discuss ways and means by which the Ferguson Organisation could help farmers, both immediately and in the future. A central relief fund was established to which the Company, its main dealers in the United Kingdom and its suppliers have since contributed generously. The fund was opened by Mr. Harry Ferguson with a donation of £500. It will be used to finance material assistance to farmers in the flooded areas.

Plant Protection Staff Changes

Mr. George Ordish, author of the recently published ' Untaken Harvest ' and head of the Export Publicity Department of Plant Protection Ltd., has been attached to the Central Agricultural Control of Imperial Chemical Industries. He will work with Dr. Watts-Padwick of the General Overseas Department.

George Ordish

Peter Sherwood

Mr. Peter Sherwood, who was previously Deputy Head of the Export Publicity of Plant Protection, has been appointed to succeed Mr. Ordish as head of the department.

Successful Gold Coast Tour

Summarising his impressions, following a tour of the Gold Coast to investigate the possibilities of farm mechanisation, Mr. E. N. Griffith, Chairman of Rotary Hoes Ltd., said: ' The Gold Coast undoubtedly needs farm mechanisation, but conditions there do not favour the establishment of a big tractor market in the immediate future. Indeed, in many areas mechanical cultivation by tractors will continue to be undesirable. There is more hope of a healthy market for the smaller type of horticultural machine, such as our Howard Rotavator " Gem," especially if the vegetable-growing trials shortly to be started are successful—and I think they will be. The important thing about mechanising Gold Coast farms is that manufacturers must be prepared to train operators. As one Chief put it, " there must be a trained African in the toolkit of every machine." I urge my fellow-agricultural engineers not to send their machines until they can meet this requirement.'

Mr. Griffith's party included Mr. John Edwards, O.B.E., M.P., and Mr. John Howard, son of Mr. A. C. Howard. The tour was made on the invitation of the Gold Coast authorities.

The installation of Mr. E. N. Griffith, of Rotary Hoes Ltd., as Togbui of Tsito (chief of the district and father of a generation) by the chiefs of the Trans-Volta Valley, during his recent visit to the Gold Coast. Mr. John Howard (*on his left*) was elected Chiami or official spokesman

Seen at a recent demonstration of the Microsol generator (*left to right*): Messrs. F. R. Frampton (Worthing grower), E. J. Cakebread (Pan Britannica Industries), K. W. Hole and J. L. Clancey (Microsol Industries Ltd.)

WORLD CROP REPORTS

BRAZIL

Intensive wheat production campaign. The national wheat campaign and government urging and assistance pushed Brazil's wheat production steadily up until 1951, when disastrous weather (that also affected Argentina) cut it down to 37,000 tons less than in 1950 (see table). However, Brazil's wheat crop for the 1952-53 season, whose harvest began last November, is expected to be about half a million tons, about one-third of the country's requirements and more than double the previous year's crop, according to Itagiba Barcante, director of the Wheat Expansion Service.

The Wheat Expansion Service, acting jointly with the Ministry of Agriculture, has taken urgent steps to supply the demand for harvesters, reapers and combines by purchasing 258 machines of various types and sending them direct to the southern wheat lands. The government has invested Cr.$20.7 million in these machines and is reselling them at cost to farmers for a down-payment of 25% and the balance in six half-yearly instalments, with interest at 7%.

Other important measures being taken by the Wheat Expansion Service include the supply of more than 200 metal silos to wheat growers. These silos have capacities of 63 to 93 tons each. In addition, a huge underground silo is being built at Erechim, in Rio Grande do Sul, and a network of 14 groups of storehouses is under construction, with a capacity of 120,000 bags (7,200 tons) each. These groups of warehouses are located chiefly in Rio Grande do Sul and Santa Catarina, and are expected to be ready in time for the 1952-53 crop.

The extensive campaign to boost wheat production and thus curtail foreign exchange expenditure is in line with the Finance Minister's dollar-saving plan, for wheat and petroleum imports alone still absorb over half of Brazil's convertible currency reserves.

BRAZIL'S WHEAT PRODUCTION AND IMPORTS

	Production		Imports			
			Wheat		Flour	
	Quantity (M. Tons)	Value (Cr.$1,000)	Quantity (M. Tons)	Value (Cr.$1,000)	Quantity (M. Tons)	Value (Cr.$1,000)
1939 ..	101,107	55,358	966,835	353,592	33,738	18,411
1945 ..	233,298	241,775	1,090,327	1,224,535	141,693	243,990
1947 ..	359,363	930,726	368,520	1,057,772	461,157	1,431,798
1948 ..	405,135	1,022,937	312,977	1,146,463	402,219	1,345,715
1949 ..	437,506	1,067,389	802,655	1,941,571	133,749	373,240
1950 ..	532,351	1,304,141	1,228,372	2,027,852	6,661	17,424
1951 ..	495,104	1,214,941	1,305,535	2,419,993	63,129	170,101

SOUTH AFRICA

Self-sufficiency in maize this year. The outlook for the South African maize crop has improved so much recently as a result of beneficial rains that there is now every chance that, not only will South Africa's own demands be met, but that a surplus will be carried over to next season.

Officials estimate the crop at 27 million bags. The Union's domestic needs are about 25 millions.

The Union's record crop was 32 million bags in 1948. A severe drought in 1951-52 caused a small crop of only 19 million bags.

Wheat and sugar. Wheat harvesting is generally completed and the latest official crop estimate is 5,681,000 bags compared with the 1951-52 harvest of 7,691,000 bags; the yield is about 3 million bags below the Union's annual requirements and the harvest's quality has been adversely affected by bad weather in several areas.

The Union's 1952-53 sugar production is provisionally estimated at 660,000 short tons, or a little below the 1950-51 record of 685,798 short tons. The yield will cover the Union's requirements and prospects for next season's cane crop have been much improved by favourable rains.

CYPRUS

Growing citrus industry. In Cyprus, citrus fruits have been grown for well over 200 years, but it is only during the last 20 years that citrus fruit production has developed into a flourishing industry, with the introduction of Jaffa-type oranges and grapefruit, the use of fertilisers and insecticides, and better irrigation and drainage methods. The area now under citrus is 8,448 acres, an increase of 34% since 1946.

Since 1944 there has been a steady increase in the number of citrus trees cultivated, and new plantings now average 40,000-50,000 a year.

During the early war years no appreciable export of citrus fruit was made and it was only in 1944 that trade with the United Kingdom was developed. By 1947 the value of exports to the United Kingdom had reached £311,591, approximately three-quarters of all citrus fruits exported. In 1950 and 1951 the United Kingdom continued as the best export market for oranges and grapefruit.

The annual income from citrus now equals the combined incomes from carobs and olives—about £1 million—and is therefore an important asset in the island's economy. The value of exports since 1935 is shown in the following table:

	Oranges	Lemons	Grapefruit
	£	£	£
1935-39 (average)	66,388	12,773	2,638
1949 ..	461,296	30,945	116,463
1950 ..	530,215	99,072	127,893
1951 ..	668,355	119,402	176,438

CANADA

Critical sugar beet outlook. Our Canadian correspondent informs us that officials of the Canadian sugar beet industry have announced plans to redouble their efforts to get protective measures from the Dominion government against unlimited dumping of low-priced raw cane sugar in Canada.

Last year Canada had produced approximately 141,000 tons of refined beet sugar, a record. The normal Canadian consumption of sugar each year is about 700,000 tons, so that about $45,000,000 will have to be spent (at current prices) to satisfy demand. The concurrent record crops in Canada and Cuba have already had their effects in Canada, where prices have declined $2.50 a cwt. in the past 15 months. The blow to the relatively new Canadian industry may be severe unless beet farmers are successful in getting at least partial protection from the Cuban surplus. Worst hit would be Alberta, where sugar beet farming has been encouraged in post-war years to diversify the agricultural economy. This province, which extracted 65,000 tons from its harvest last year, is not only able to supply the domestic needs of its population, but has a 15,000-ton surplus in 1952 for supply to Saskatchewan. During 1952 imported Cuban sugar has been sold mainly in Eastern Canada. West of Winnipeg, the sugar beet industries of Manitoba, Alberta and British Columbia have grown so they can now meet 75% of western Canadian demand. But if world sugar prices continue to fall—as seems likely with the excellent 1952-53 Cuban crop prospects—West Indian refined will al-

most certainly be sold in larger quantities in Western Canada, despite the high trans-Canada rail freight rates.

This will bring such competition that it will probably take a full year for the marketing of the record 1952 western Canadian crop. It will also mean the western beet farmers will get considerably less than $14.50 per U.S. ton of beets, the price they received for their 1951 crop. If the drop is very great, acreage put under beets in 1953 may be seriously reduced.

INDONESIA

Sugar production in East Java during 1952 totalled 269,646 tons, compared with 232,284 tons in 1951 and 148,410 tons in 1950, and the number of sugar mills has correspondingly increased: there were 15 in 1949, 18 in 1950, 26 in 1951, and 28 in 1952, with a prospect of 30 in operation this year.

Mass production of clove substitute will be started shortly, following experiments made in 1951. Experimental work on the production of substitute cloves was intensified as the foreign supply of cloves became more and more difficult and barely met the annual amount of 10,000 tons needed by the industry manufacturing 'rokok kretek' (clove cigarettes). In 1952 only 6,000 tons were imported due to high prices in the foreign market. The importance of cloves can be imagined when it is realised that 80,000 workers were employed at the 'rokok kretek' factories. In addition to the production of synthetic cloves, the production of natural cloves in Ambon has been intensified.

INDIA

Second estimate of acreage under cotton. According to the Directorate of Economics and Statistics, Ministry of Food and Agriculture, the all-India second estimate of cotton, 1952-53, puts the area at 12,304,000 acres, as against 12,343,000 acres of the adjusted corresponding second estimate for last year, thereby showing a decrease of 39,000 acres or 0.3% in area. Details according to trade descriptions for the current and last years are as follows:

Variety	*Area (thousand acres)*	
	1952-53	1951-52
Bengals ..	1,112	1,007
Americans ..	643	656
Oomras ..	4,287	4,097
Broach	853	810
Surti	489	367
Dholleras ..	1,314	1,170
Others	3,606	4,236
Total ..	12,304	12,343

This decrease in acreage under cotton has been shared mainly by Hyderabad, Madhya Bharat and Mysore, and has been attributed to some decline in sowings due to lack of adequate rains from the middle of July to the third week of September 1952. The decrease in acreage has, however, been offset considerably by increases registered mainly in Madhya Pradesh, Bombay, Uttar Pradesh, Saurashtra, Punjab and P.E.P.S.U., due partly to the efforts made to grow more cotton under the Integrated Production Programme and partly to favourable weather conditions at the time of sowing.

This estimate does not cover the entire area sown to cotton crop. Past experience shows that the final estimate of acreage is about 32% higher than the second estimate.

FRANCE

Grain areas. According to a *Reuter* report from France the following areas are now under grain: wheat, 3,767,300 hectares; rye, 413,400; barley, 325,800; oats, 594,900; other grains, 33,600. These figures compare with the following respective areas in February 1952: 4,073,200, 463,900, 299,300, 594,300 and 33,200.

ISRAEL

Citrus exports now two million cases. Citrus exports from Israel reached a total of 2,096,745 cases on February 1. More than half were sent to the United Kingdom, which received 1,083,957 cases of oranges, 170,163 cases of grapefruit, and 96 of lemons.

Consignments to other countries were as follows: Norway: 210,000 cases of oranges, 25,000 grapefruit; U.S.S.R.: 141,453 oranges; Sweden: 85,724 oranges, 9,943 grapefruit; Finland: 80,008 oranges, 14,992 grapefruit; the Netherlands: 63,306 oranges, 9,000 grapefruit; Belgium: 36,140 oranges, 25,552 grapefruit; Denmark: 53,231 oranges, 5,984 grapefruit; Poland: 22,254 oranges, 1,000 grapefruit; Eire: 15,000 oranges, 1,000 grapefruit; Austria: 14,550 oranges; Switzerland: 13,648 grapefruit; Yugoslavia: 9,997 oranges, 3,789 lemons; and Rumania: 958 oranges.

BRITISH GUIANA

1952 sugar target expected to be reached. Although reaping was held up by the rains it was expected that the colony's target of 230,000 tons of sugar would be made, according to a report in the *West India Committee Circular*.

Rice production. It has also been estimated that the colony's rice production will be about 64,000 tons.

EGYPT

Increasing exports of cotton. Exports of raw cotton from Egypt during August-October 1952, the latest months for which official statistics are available, totalled 451,000 bales (500 lb. gross), compared with only 162,000 bales during the comparable period a year earlier.

The principal recipients of Egyptian cotton during August-October were France, Italy, the Soviet Union, and Western Germany, shipments to which amounted to 67,000, 67,000, 51,000, and 47,000 bales, respectively.

Stocks of raw cotton held at the beginning of this season (August 1, 1952) were at a very high level, totalling 892,000 bales, of which about 370,000 bales were government-owned. Most of these stocks were purchased under the 1951-52 purchase programme. On November 27, 1952, government-held stocks of 'old' cotton, *i.e.* 1951-52 or earlier, are reported to have been reduced to about 325,000 bales. This total includes 135,000 bales of Karnak, 10,000 of Menoufi, 130,000 of Ashmouni, 23,000 of Zagora, and 27,000 of Giza 30.

Consumption of raw cotton this season has been at about the same or slightly lower level as last season. Consumption in 1951-52 totalled 292,000 bales. During the past two years, when the Egyptian Government fixed the export prices of raw cotton at levels above the world market, foreign spinners who required Egyptian types of cotton found it profitable to buy yarn rather than cotton, inasmuch as the price of yarn was not controlled. However, now that both Egyptian cotton and yarn prices are near world price levels, there is less demand than formerly for yarn.

With respect to production this season, the second official estimate, released on December 3, 1952, places this year's crop at 1,946,000 bales. Production during 1951-52 totalled 1,666,000 bales.

Announcement was made earlier of the curtailment of cotton acreages in 1953-54. The present large stocks, together with this year's large crop, may result in an intensified effort to reduce next season's acreage. (From *Foreign Crops and Markets*.)

BURMA

Cotton forecast. The Government of Burma recently released its second forecast of the 1952-53 cotton acreage. It placed the acreage for harvest at 247,000 acres, an increase of 7,000 acres over the final estimate for last season. The 1952-53 production is expected to be slightly lower than the 1951-52 crop of 75,000 bales (of 500 lb. gross).

COMPANY NEWS

Asahan Rubber Estates

A RECORD CROP

Mr. A. L. Mathewson's Address

The fortieth annual meeting of Asahan Rubber Estates Ltd. was held in London on March 6.

Mr. A. L. Mathewson, O.B.E., the chairman, presided.

The following are extracts from his address:—

During the year under review, 1,907,089 lb. of rubber were harvested. This record crop was nearly 60% more than the preceding year's collection and was over 30% greater than the 1940-41 harvest, the previous highest.

The trading profit for 1951-52, before taxation, was £103,219, an increase of £33,751 over the previous year. This creditable result assumes a very different and discouraging aspect when the necessary provisions have been made for the heavy hand of the tax-gatherers.

Even after deduction of the anticipated unilateral relief from double taxation our tax bill covering company tax in Indonesia and also profits tax, Excess Profits Levy and income-tax in the U.K. aggregates no less than £74,691, or over 72 per cent. of the net trading profit. To give the full picture I might here interpolate that prior to the trading profit being struck, export duties and the operation during the first half of the year of the exchange certificate system had already relieved us of an equally heavy amount.

Incentive-destroying taxation

The year's profit before charging all of the various imposts detailed was approximately £177,000, and the company is thus mulcted by the two Governments in about 84% thereof, representing the equivalent of substantially over 100% on its capital. Particularly to a company which, in common with other similar companies, is bearing in full the heavy cost of restoring grievous damage and loss resulting from the war and subsequent events this is an intolerable burden out of all proportion or reason. It exemplifies the gravely paralysing effect on oversea enterprise of present-day punitive, incentive-destroying taxation both in the U.K. and abroad. In these circumstances we note with particular interest the issue last week, in response to the request of the Chancellor of the Exchequer, of the first interim report of the Royal Commission on the Taxation of Profits and Income and the recommendations made therein as regards the taxation of oversea profits. If given effect to in the forthcoming Budget, as we trust they may be, these interim recommendations would go some part of the way by removing certain of the most glaring injustices, but would still leave companies such as this at a serious disadvantage as compared with competitors controlled locally or in certain foreign countries. It is to be hoped, therefore, that the Commission, before completing the heavy task of dealing with the weighty submissions before it, may see its way to make further recommendations which would have the effect of putting overseas British enterprise such as ours in a fully competitive position.

After deducting the interim dividend of 8%, less tax, paid in respect of 1950-51 on April 10, 1952, and making the provision and transfer detailed in the appropriation account, the balance carried forward on the latter amounts to £38,434, against £29,932 brought in.

The report and accounts were adopted.

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Particularly, we would like these details: Pump identification (stamped on top of pump housing), when and from whom purchased, number of hours' operation, area and crop sprayed, liquid pumped, power source and present condition of pump. A simple sketch of the pump installation on your spraying equipment would be helpful, and suggestions for improvement of pump design are very welcome.

We propose to accumulate this detailed information and make it available to interested agriculturists around the world with the same or similar spraying problems.

May we hear from you? Address:

Del Digney, Director
Agricultural Pump Div., Oberdorfer Foundries, Inc.
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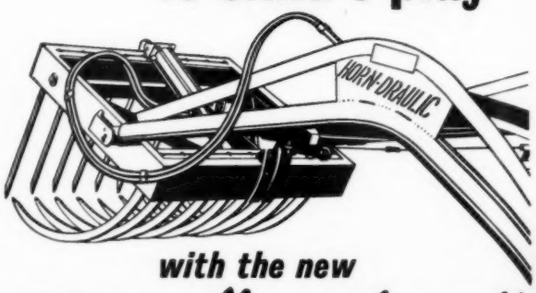

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